
Statements and Papers from the 2nd Northern Resource Conference, Whitehorse, March 25, 1996

[Canada] [Conferences] Northern resource conference, 2nd

[Statements and papers]

[1] Canada's economic growth and the Yukon by Louis Couillard. 1966.

[2] Yukon development for the future; an address by the Honourable Arthur Laing, Minister of Northern Affairs and National Resources to the Second Northern Resource Conference, Whitehorse, Yukon Territory, Friday, March 25, 1966.

[3] Paving of Alaska Highway key to Yukon tourist potential by Charles B. West. 1966.

[4] Base metal smelting and its application to Yukon mineral development by Charles I. Brown. 1966.

[5] Developing mines in the north by C.H. Macdonald. 1966.

[6] Mineral potential of Yukon by L.H. Green. 1966.

[7] Thermal power generation by W.G. Sterling. 1966.

Notes for Talk by
Mr. Louis Couillard,
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Economic Council of Canada

Second Northern Resource Conference,
Whitehorse, YUKON,
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# "CANADA'S ECONOMIC GROWTH AND THE YUKON"

Introduction .....

The excellent papers presented at the First Northern Resource Conference in 1963 and the equally first class papers presented at this Second Conference have very fully covered the economic life and development of the Yukon.

My task today is to tell you something about the economic potentialities and problems of the Canadian economy as a whole. I hope that I can do this in a way which will be useful to you and help you situate your vast and rich territory in the broader national setting in which this and all other regions of Canada operate.

I need hardly stress the relationship which exists between the rate of economic development and activity in the Yukon and the economic health, so to speak, of Canada as a whole. And I have in mind here not only the fact that the economic growth of this and other regions of the country can be influenced to an important degree by the over-all rate of economic expansion in Canada, but also the equally important contribution which each region can and must make to the growth and development of the national economy and the country as a whole.

In my remarks, I shall try to provide at least partial answers to a number of basic questions which concern us all as Canadians: What are this country's long-term economic and social goals? What are our economic potentials in relation to our basic goals? What has been our performance and what broad economic policies are required to meet our problems and to reach our potentials and goals?

Second only to questions of war and peace, perhaps the greatest challenge which nations face today is to reach certain basic economic and social goals simultaneously and consistently. Canada shares these goals with all like-minded countries around the world. They can be briefly stated as follows:

- full employment
- a high rate of economic growth
- reasonable stability of prices
- a viable balance of payments, and
- an equitable distribution of rising incomes.

These five goals taken together represent real economic growth and progress. Our performance in Canada in the past five years has been good, at least with respect to our first four goals. Ever since Confederation, regionally balanced economic development, which is an important aspect of our fifth goal, has been an implicit, if not an explicit, objective of national policy. But the fact remains that we have not succeeded in narrowing the very wide economic disparities which have persisted, almost unchanged over the past forty years, between the main regions of this country.

Our relatively good performance in the past five years with respect to our first four goals has not always been the rule in the post-war period. Indeed, our poor over-all performance compared to that of other countries has demonstrated that we cannot count on the automatic attainment of our baisc goals. Furthermore, the trick is to attain all five goals simultaneously and on a sustained and sustainable basis. This is made all the more difficult by the hard fact that the goals are not always compatible with each other. For example, policies designed to accomplish full employment and a rapid rate of growth may quite easily be in conflict with the policies needed to avoid inflation or to maintain a viable balance of payments position with foreign countries.

I stress this question of compatibility of goals because, as you know, it is a very real issue today at a time when the economy, over-all, is operating at 97 to 98% of potential output. In these circumstances all those concerned with policy decisions, both in the public and private sector of the economy, have a much more difficult task in striving for strong, sustained and balanced economic and social progress along with reasonable price stability and a viable balance of payments.

To help in this task is the main purpose of the Economic Council of Canada which was set up by Parliament in 1963. Indeed, the Council's main assignment is to do the co-ordinated research necessary to define our five national goals

more precisely over the longer term, to set out our economic potentials and to recommend how best they can be attained through the application of coherent and longer-term economic, financial, fiscal, trade, development and other basic policies. To date the Council has issued two main reports or Annual Reviews (and a number of supporting studies) which set out the results and conclusions of its research work and its agreed recommendations which are intended to provide an over-all and coherent framework of medium- and long-term policies both for the government and the private sectors of the economy.

As you know, most industrially advanced countries now try to establish such an over-all framework of policy in greater or lesser detail and through various means and agencies. In Canada, the Economic Council, as a research and independent advisory body, is a relatively new development in the field of economic policy formulation. I would add that the setting for the first time of national economic potentials and targets by the Economic Council represents a significant consensus concerning the tasks, the problems and the public and private policies involved in meeting our economic and social goals consistently. I say this because the Council is a fairly representative and independent adivsory body. Its twenty-eight members are drawn from the various regions of the country and the main sectors of the economy, including top labour and management, commerce and industry, agriculture, mining, as well as the general public. There are no governmental representatives.

Three members serve full time and the Council has a first-class staff of about thirty-five economists and other specialists to advise it.

It might be useful in the light of the foregoing, to outline briefly some of the main potentials which the Economic Council has recommended as desirable and realistic targets for the economy to reach over the medium term to 1970. We can do this in respect to the national goals I enumerated earlier and at the same time, review briefly the economy's actual performance in the past few years.

1. The maintenance of a high level of employment

As you can appreciate, the setting of this target by a representative Council, required a good deal of basic research into population growth, immigration and emigration, to arrive at forecasts of our labour force growth and its composition. On the basis of this research, the Council agreed that a realistic, although not an ultimate or ideal goal to be aimed at to 1970, would be an average rate of 97% employment of the labour force, that is no more than 3% unemployment for the economy as a whole.

As you know, the actual performance of the economy in 1964 and 1965 with respect to our national employment target, has been good. Unemployment appears to have fallen, after allowance for seasonal factors, to about 3½% of the labour force, that is to about half the 1960 rate and only moderately above the Council's target.

This target was agreed by the Council, about 18 months ago, in the knowledge of two important factors: (i) that at that time the rate of unemployment was relatively high and (ii) that our labour force would be growing over the next several years at a faster rate than in any other industrialized country in the world. This will be a basic, unalterable reality in the Canadian economy for several years to come. In this sense, Canada is unique. In fact, the increase in our labour force is likely to be several times the rates of increase in most European countries, and well over 50% higher than that in prospect in the United States.

The dramatic and unprecedented addition of over 1,000,000 persons to our labour force between now and 1970 has received a good deal of publicity and I think that more and more Canadians are aware of the continuing challenge this represents if we are to meet our national target of no more than 3% unemployment by 1970. The challenge in fact is an opportunity for us to make substantial progress in the economic growth because the size of our labour force which governs the quantity of our productive resources, is one of the three main factors which will determine the expansion of the Canadian economy.

The other two factors which will determine our rate of total output and our standard of living will be the extent to which we can improve the productivity of our human and material resources,

that is the rate of expansion in output per employed person. We can do this by improving the quality of our productive resources and the efficiency with which we use them. Increased productivity is a vital factor in our second national goal.

2. A high rate of economic growth

The Council estimated that to achieve our basic goals by 1970 will require an average expansion of 5½% in the total volume of goods and services which Canadians produce each year. As I have said, this volume of output will depend on the size of our active labour force and on its productivity, that is on the growth of output per employed Canadian.

By way of comparison, the output target of 5½% is roughly the average rate of annual increase in our Gross National Product over the period 1949-56; these were good years in Canada in terms of production growth. On the other hand, 5½% is substantially higher than we have achieved on the average since the end of the war. We should not, however, consider a target rate of 5½% unrealistic for all that, given the record rate of increase in the Canadian labour force and the need to provide the necessary employment. I would add that over the past decade the Canadian economy has experienced one of the slowest rates of growth of any industrially advanced country in the world, both in terms of average living standards and of average productivity. We have, therefore, some catching up to do. We must remember also, lest we are inclined to think that a target rate of 5½% is overly optimistic that for the last two decades, our level or real income per capita has been consistently 25 to 30% below the level of income

per capita in the United States.

In terms of performance, our total output of goods and services in the past five years has enjoyed a very rapid rate of expansion in relation to historical experience in Canada. It also represents a performance which compares favourably with the growth performance of the United States and other industrially advanced countries over the past five years. The existence of a substantial amount of economic slack at the beginning of the 1960's -- in the form of high unemployment and considerable underutilization of our productive facilities -- was an important factor facilitating our high rate of growth in the last five years. By 1965 much of this slack had been eliminated and, as I have said, the economy is now operating closer to potential than at any time in almost a decade; the Canadian economy is now operating at a rate which is estimated to be only about 2 below potential, compared with 8 or 9% below potential in 1960-61.

Productivity gains in the Canadian economy in the last five years have been much better than in the previous five years. (1955 to 1960 - 0.9%). However, our gains have not been as high or as fast as many economists had expected and they do not appear to have risen as rapidly as in the United States. Moreover, our productivity performance in 1965, according to available measures, has been somewhat disappointing.

3. A reasonable stability of prices and competitive costs of production

With respect to this important goal, the Council considered that rates of change in prices and costs to 1970, within our flexible market system, should be contained within the limits recorded over the decade from 1953 to 1963. Over these years, for example, the average annual increase in consumer prices was 1.4%; in the prices of all goods and services produced in Canada, the average annual increase was 2.0%. There were of course, some moderate year-to-year variations around these rates.

The performance of the Canadian economy as regards prices and cost stability over the past five years as a whole has been very good - better than in the first fifteen years after the war and better than in all other industrially advanced countries with the exception of the United States. Moreover, this relatively good performance was achieved despite the devaluation of the Canadian dollar during this period -- a development which might have been expected to exert some upward pressure on prices.

Despite the generally good performance of costs and prices for the first half of the 1960's as a whole, some pressure points affecting costs and prices had emerged by 1965 as the economy came closer to potential output. This is particularly the case in the construction industry. The risks of possible general

inflationary pressures have become greater in these circumstances. This, of course, is the problem of compatibility of our basic economic goals which I mentioned earlier. It is also an important matter as regards our fourth national goal.

4. The absence of serious pressures on our balance of payments with other countries

The Council took this to mean both the maintenance of adequate total international receipts to cover our international payments, and the strengthening of Canada's international economic position. The possible current account payments deficit at potential output, that is if we meet our targets in 1970, might be of the order of $1.5 to $2.0 billion per year. Such a deficit would be lower in relation to total domestic output than has been the case under comparable past conditions of rapidly rising activity in Canada. Similarly, the corresponding net capital inflow would be smaller in relation to domestic investment than has been the case in the past. In short, to attain our economic and social goals including a viable balance of payments with foreign countries, calls for some improvement in the basic competitive posture of the Canadian economy.

A variety of evidence suggests that the economy has become more internationally competitive over the first half of the 1960's perhaps particularly as a result of the impact of the devaluation of the Canadian dollar. At home, Canadian producers

have move aggressively in various lines to take over a larger share of the domestic market. At the same time, we have witnessed a pattern of striking export successes by Canadian producers, over a widening range of products and to an increasing number of export markets. In particular, Canadian producers have moved dynamically to participate in the remarkable increase of international trade in highly manufactured products and we have had a tripling in the volume of our exports of highly manufactured products over the past five years -- a major boom in such exports for the first time in our history. This is a sign of a new industrial maturity in the Canadian economy.

5. An equitable distribution of rising incomes

An important aspect of this goal was examined in the Council's Second Annual Review published two months ago, namely, the question of regionally balanced economic growth and the reduction of disparities among the regions of Canada. These are long-standing and difficult questions and the Council has made a start in spite of serious conceptual problems and statistical deficiencies. Indeed it is largely because of this lack of statistics that the Yukon and the Northwest Territories could not be included in our more detailed research in spite of the Economic Council's concern with the goal of balanced economic development as between all regions of the country. As you will know, the Council expressed the view that the North embraces a vast, sparsely settled area, and presents special economic and

physical characteristics, all of which suggest that a separate study of the area would be required.

I have no doubt, however, that at least a few of the broad conclusions which the Council reached in its regional studies, and perhaps also some of the policy suggestions and recommendations it made would be applicable to, say, the Yukon even though our studies and therefore our facts relate exclusively to the historically older, closer, more highly settled and economically more developed regions of Canada. I would invite you, therefore, to have a special look at those sections of the Council's Second Annual Review which deal with regional growth and disparities.1/

As you will see the Council's research work establishes clearly the long-run persistence and the substantial size of the income disparities among the ten provinces. In analyzing some of the reasons for these disparities, the Council concluded that about half the difference in per capita earned income between the Atlantic Region and Canada as a whole, for example, is

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1/ The Council will also be publishing in the next few months a number of background Staff Studies which should be of major interest to those concerned:
Internal Migration in Canada, 1921-61, by Isabel B. Anderson;
Interregional Disparities in Income, by S.E. Chernick;
An Analysis of Interregional Differences in Manpower Utilization and Earnings, by Frank T. Denton;
Interregional Disparities in Public Services, by T.K. Shoyama.

explained by differences in the size of the employment base or, if you like, differences in the extent of availability and utilization of manpower in the Maritimes. Another key factor in explaining interregional income differences is the level of education of the labour force and the consistently lower productivity performance in all sectors of the economy in the less developed provinces.

As the Economic Council has put it, there are two main interrelated considerations involved in moving towards a better regional balance. The first is the importance of reducing the relative disparities in average levels of income as they presently exist among the regions. Incidentally, the United States have a much better showing in this respect that we have. The second consideration is the need to assure that each region contributes to total national output, and to the sustained, long-run growth of that output, on the basis of the fullest and most efficient use of the human and material resources available to the region. The Council, in its recommendations, has set out what it called "fundamental criteria and guidelines for action". I cannot take the time to speak about these guidelines but they are appended to the text of my remarks.

I might add, perhaps as further concrete evidence of the Economic Council concern with the problems of regionally balanced economic development, that members of the Council have recently accepted the imaginative invitation of the Honourable Arthur Laing, Minister of Northern Affairs and National Resources to visit the North, probably some time this summer. Pressure of work last year had made it impossible for us to accept Mr. Laing's invitation.

Returning to the economic problems and prospects of the Canadian economy as a whole, I would point out that an important development which has been taking place in recent years is that more and more our national economic policies -- and judging from the results of the Economic Council's surveys, business policies as well -- are being viewed as part of a longer-term framework of coherent growth policies.

Needless to say, much remains to be learned and to be done with respect to the economics and the policies of growth and of change. But progress is being made and the United States, in particular, has managed to keep its huge economy on a remarkably even keel. Moreover, modern science and technology, which is responsible for much of this growth and this change, is making available new methods and tools which increasingly should help discourage ad hoc, short-term considerations and issues from dominating the government and the private sector of the economy.

This is an important factor in the rather finely balanced conditions which now prevail in both the American and the Canadian economies: underestimation of potential dangers of overheating could lead to a very unfortunate exposure of our economy to inflationary burdens and dislocations. On the other hand, exaggeration of the significance of particular strains, such as exist in the construction industry in many parts of Canada and failure to act in time to ease these strains, could lead to unnecessary general restraint actions which would have the effect

of stalling economic growth and generating higher unemployment. This, of course, is the question of compatibility of goals which I mentioned earlier.

In this finely balanced set of conditions, it seems to me particularly important for companies to attach a high priority to well-informed medium-term planning. I have particularly in mind the need for manpower planning, which becomes crucial in a high-employment economy, as well as investment planning.

Along with more forward-looking policies, the economy must turn out a better job with respect to productivity. Since we cannot do very much about the quantity of our productive resources, our future economic growth and well-being depend largely on the degree to which we can improve the quality of our resources and the efficiency with which we use them. This, of course, is why the Economic Council considered that our most important current economic problem is to achieve and maintain adequate productivity growth.

Many complex factors are involved in this task -- and government, management and labour each have their share of responsibilities to assume and each has a vital role to play. Rising productivity is not only the key to our economic and social goals, but it can also ease the problems of compatibility as between these goals. In addition to enlarging incomes, improvements in productivity are important for increasing

profitability and competitiveness in the Canadian industry, for better interregional balance, for providing growing resources for social purposes, and for maintaining a viable balance of payments.

In striving to improve productivity in the Canadian economy, the quality of our labour force is a crucial factor. This is why the Economic Council has stressed vigorously that top priority must be placed on education and training as the most important and promising way of improving what is by far our greatest productive resource -- Canadians. Roughly three-fourths of all income in the economy accrue. to the labour force, reflecting the contribution of our human resources to national output and growth. Consequently, the quality of all sectors of the labour force -- workers and farmers, supervisors and managers -- as determined by education, training, experience, skill and managerial competence, and the application of initiative and effort, plays a very large role in improving the productivity of the economy. A striking example of what I am saying is that well over one-third of the productivity or the income difference of 20% which exists between Canada and the United States, can be accounted for by the relatively much higher level of educational attainment in the American labour force. There is evidence to show also that the average differences in educational level in the two countries are generally greatest as regards the owner and management groups.

The Economic Council has also made strong recommendations designed to achieve greater efficiency in the use of our productive resources: it has attached prime importance and urgency to the need for better manpower and labour-market policies and programmes; has stressed the need for Canadian producers to obtain the maximum

economies of specialization and scale through policies designed to widen markets and to lengthen production runs; the Council has also recommended a bold approach in our trade policies, along with government-financed adjustment programmes to assist particular industries and groups of workers which may be adversely affected by the reduction of trade barriers. Specific policies have also been recommended for expanded research and development.

In conclusion, let me point to a rather striking and, I think, stimulating comparison concerning Canada's current economic problems and prospects. Five years ago, we faced major problems of how to reduce unemployment, increase employment, generate faster growth, improve our international competitiveness and reduce the substantial external deficit and net capital inflow which were so inappropriate in the circumstances of high unemployment. Today, the central task we face is not so much that of achieving quantitavely higher standards of economic performance, but rather of meeting the problems associated with our success towards the goals we have been striving to achieve.

These problems are in fact the challenges of economic growth and of prosperity: the challenge of adequate and balanced expansion in productive capacity under strong demand conditions; the challenge of increased dangers of excessive price and cost pressures; the challenge of facilitating manpower and other adjustments to swift and pervasive changes in our economy; the challenge of stronger growth in productivity, of improving the quality of our productive resources and of achieving greater efficiencies in production; and the challenge of improving further the international competitive strength of the Canadian economy both in the domestic and in markets around the world.

There is no doubt that ahead of us in the balance of the 1960's lies a period of large opportunity. According to our view of Canada's potentials, it should be a period in which we could again achieve a growth of over a quarter in the size of our economy. This will call for high standards of decision-making in all areas of our economy not least of all in the private sector. This is the true measure of the importance and the responsibility of the private sector in the Canadian economy.

APPENDIX

Extract from Second Annual Review

of the

Economic Council of Canada

"TOWARDS SUSTAINED AND BALANCED ECONOMIC GROWTH"

Chapter 7 - "Conclusions and Recommendations"

"Policies for Regionally Balanced Economic Growth"

Over the past four decades there has been relatively little progress towards the achievement of a better balance in the economic development of the different regions of Canada. Despite various policies and programmes, very wide disparities have continued to persist in average per capita incomes. Also, there have continued to be wide differences in the extent to which the human and material resources of each region have found opportunities for productive use. While national prosperity has always tended to have a widely diffused favourable influence in all regions, rapid national growth has not by itself served to bring about any significant or lasting reduction in these large and stubborn differences.

The smaller per capita incomes at the lower end of the scale of interregional disparities; namely, the Atlantic Region and Quebec (mainly the eastern portion of the province), have been due in part to a relatively low utilization of the available human resources arising from a lack of economic opportunities; and, in part, to a generally lower average level of earnings across virtually the entire structure of economic activity. These smaller rates of earnings reflect circumstances which have an adverse effect on productivity; namely, generally lower educational and skill attainments, smaller scales of output and long distances from large markets, smaller stocks of productive facilities and of social capital, less abundant natural resources, inadequate use of developing technology, and lower scales of public expenditures and investment in growth-promoting services.

Efforts to promote more regionally balanced growth should be aimed at achieving a more rapid increase in the incomes of the lagging regions by methods which do not retard the development of the faster-growing regions of the country. In this way the economic growth of the national economy would be improved to the benefit of all regions in Canada. In order to accomplish this result it is essential that regional development policies be directed to two basic objectives -- the increase of opportunities for high-productivity employment, and the acceleration of programmes which can make the maximum contribution to improvements in productivity generally in the region. These objectives involve the following fundamental criteria and guidelines for action:

(1) the avoidance, as far as possible, of subsidies merely to create temporary activity or to sustain indefinitely low-productivity industries and declining occupations;

(2) encouragement of efficient agglomerations of activity -- growth centres -- within the different regions in order to achieve increasing economies of scale, larger markets, and more useful pools of skills, and to avoid uneconomic scatter and dispersion;

(3) the taking of decisions in respect of investments in social capital in accordance with an adequate consideration of the economic and social benefits to be obtained in relation to costs;

(4) the recognition of the urgent need to make available additional financial resources to the governments of the lower-income regions and through the appropriate federal agencies in order to help break the vicious circle of low productivity, low incomes, low government revenues and low investments in growth-promoting services which are needed to improve the quality and effective utilization of the available human and material resources -- in particular, education, training, research, health, transport facilities, resource and industrial development, and the development of wider markets;

(5) the necessity for close co-ordination in the formulation and implementation of consistent regional development policies and programmes among all levels of government (this is particularly important in view of the wide range of programmes and policies affecting regional development, both on the part of the provinces, and through certain federal agencies such as the Atlantic Development Board, the Area Development Agency, and the Agricultural Rehabilitation and Development Administration);

(6) the avoidance of self-defeating restrictive and divisive measures which interfere with the free flow of goods, capital, labour and enterprise between all the provinces. Such measures must be avoided if we are to achieve simultaneously the twin goals of more satisfactory growth in every region and a rapid expansion of the national economy from which all would benefit.

It is clear that the narrowing of interregional income disparities and the achievement of a more regionally balanced economic growth involve large, urgent, and especially challenging tasks. Many decades of experience have shown that these tasks cannot be accomplished by piecemeal expenditures, superficial expedients, unproductive works, and mere transfers of income. The appropriate policies and programmes will need to be formulated within a long-run consistent framework and carried out with a continuing regard for the real and underlying problems involved.

PRESS RELEASE COMMUNIQUÉ

Department of Northern Affairs
and National Resources
nformation Services Division

Ministère du Nord
des Ressources nationales
Division des services

NOT FOR RELEASE BEFORE
6 P.M. Yukon Daylight Time
Friday, March 25, 1966
10 P.M. Eastern Standard Time

# YUKON - DEVELOPMENT FOR THE FUTURE

AN ADDRESS

BY THE

HONOURABLE ARTHUR LAING

MINISTER OF NORTHERN AFFAIRS AND NATIONAL RESOURCES

TO THE

SECOND NORTHERN RESOURCE CONFERENCE

WHITEHORSE, YUKON TERRITORY

FRIDAY, MARCH 25, 1966

There can surely be little doubt in our minds tonight that the Yukon is once again on the move, that the period during which little seemed to be happening and when the future seemed hazy is over. For the moment, at least, many of the barriers have been lifted and economic, social and industrial expansion is likely to take place to an extent that would not have been thought possible as little as 12 months to two years ago.

Although I am sure many of you were aware of the changing situation, this conference has enabled us to look at the picture as a whole and to assess in very real and practical terms just what does lie ahead and perhaps even to form some idea of the tremendous potential for development in the larger term. For years we have heard specialists in one field or another say the Yukon has a tremendous future and yet try as we might it always seems to be difficult to convert these predictions into reality. I believe, and I think most of you will agree with me, that we are here today on the threshold of that reality. There will still be many problems and some of you may not feel the beneficial effects for some time but at least we are beginning to outline specific projects and developments that must lead to further growth and improvements.

I am sure I express the views not only of everyone gathered here tonight but of all Yukon residents when I extend my sincere congratulations to the Yukon Chamber of Commerce, to the Yukon Chamber of Mines, and particularly to those many individuals of both groups who have worked so hard to bring about this conference. Its timing is most opportune; the organization has been excellent, the substance has provided a unique educational opportunity and it has rekindled our enthusiasm by establishing a new plateau from which all concerned with the Yukon's resources can move forward knowing that they can rely on a solid background of facts. I would, therefore, like to extend my personal congratulations for a job well done to the conference committee, under the able chairmanship of Bob Campbell. I am sure that the success of the conference is reward enough in itself and looked at in this light the reward is, indeed, large.

As the conference draws to a close we must turn our attention to the steps that should be taken to put into practice some of the ideas that have been developed here during the past few days and to ensure that there is no undue delay or loss of momentum in the future. I know that for my part, I shall do my best to ensure that the federal government supports, wherever reasonable and possible the many projects that must surely develop.

The federal commitment to the Yukon Territory is large and although we may not always agree on some of the details I think it is fair to say that the federal contribution to Yukon economic and industrial development to date has been significant. The government might, perhaps, have done more in some areas and less in others but what wonderful prophets we would all be if we had the benefit of hindsight before making our decisions. Lest you are now preparing yourself for a long recitation of past accomplishments let me assure you that it is to the future and not the past that I want to look tonight. If we seize on those opportunities which are now before us, and turn them to the benefit of the Territory, this surely is what we all want. I am convinced that this can best be done in the spirit, not only of co-operation, but of mutual understanding and respect.

The first step which the government can take is to examine the present administrative and government organization in the Territory in the light of the rapidly changing economic and social patterns of today. It is evident that the time has come to thoroughly investigate such questions as the long range constitutional development of the Territory, the proper responsibility of the Territorial Government in relation to the Federal Government and the timing of the steps to be taken to achieve desired objectives in this sphere.

As a result of the suggestions by your Commissioner, Gordon Cameron, and other representations made to me, I have been considering the establishment of an advisory commission on the development of government in the Yukon Territory and hope to be in a position to come to a conclusion on this matter this year. This would not be a royal commission which would take several years in its deliberations and on the other hand, it would not be a group associated with government. It would be composed, as is "The Advisory Commission on the Development of Government in the Northwest Territories", of able and respected men able to take an independent and objective look at the situation.

Such a Commission would provide an opportunity for all individuals and groups having views on the future of the Territory to come forward and not only be heard but have their suggestions and ideas carefully assessed. There may, indeed, be a concensus with respect to the future development of the Yukon, although this is not certain, but I am sure that there is, at the moment at least, no concensus with respect to timing, methods of

achievement, financial capabilities, or a host of other important aspects that are basic to this development. It seems to me that an advisory commission might be the quickest and most efficient way of obtaining these views. Little progress can be made until we are in possession of many more facts than are available today and until we have heard as many viewpoints as possible. In anticipation of the probability of a commission, a certain amount of preparatory work has already been undertaken in the Department. The first step has been to bring together a group of officials having some knowledge of the Yukon both from Ottawa and from Whitehorse to collect as many of the facts as possible concerning the economy, resources, population, and various other items of statistical data in a basic reference paper. As you may know, a similar reference paper was prepared for the Advisory Commission on the Northwest Territories.

In addition, and as a prerequisite to much of the work of the Commission, the government has agreed that a comprehensive economic study of the Yukon be undertaken. This can, in part, be carried out by independent consultants. It is likely to be quite extensive but if its purpose is clearly defined and fulfilled, it will be well worth the time and effort. Not only will it include matters of particular interest to Yukon residents it will also provide some of the answers sought by the federal government. I was much impressed by the initiative of the Yukon Council in voting $150,000 for such a study. It has been indicated to me that a joint approach might be useful. I believe such a study should be commissioned, financed and directed jointly by both the federal and territorial governments. I want to be sure that the objectives set the terms of reference and the specifications of the study itself meet with the approval of Yukoners as represented by the Council and that there is agreement as to the consultants to be employed.

I am hopeful this study will identify specific projects that could be introduced or supported to further the economic development of the Yukon. In some of these the federal government participation will, no doubt, be desirable and therefore, federal participation at the outset is both logical and desirable.

I would also like to mention that we are strengthening the staff of the Department, in order to be able to deal in a more effective manner with the many aspects of northern economic and industrial development.

Approximately a year ago I announced the establishment of a Resource Development Branch within the Department for the purpose of expanding our work on the development and co-ordination of national resources. I said at the time that there would be special emphasis placed on the development of northern resources and additional work would be done on the northern economic picture. In the recent reorganization of Departments no change whatsoever has been made in the responsibility of this Department and myself as Minister for the economic well being and expansion of the Yukon. I think you will agree that since the future development of the north will to a large extent, be dependent on the successful exploitation of these resources, it is both logical and sensible to retain under one Minister, responsibility not only for social and political development but also for resource and economic development in the north.

Therefore, there has been no change in my responsibilities with respect to either the Yukon or Northwest Territories, and I am delighted to continue this association with the north.

The change in portfolios has also brought together all the federal government agencies responsible for Canada's indigenous peoples and I most certainly welcome this opportunity of being associated with the social and economic advancement of the Indian peoples throughout Canada. It should be highly advantageous, and economical, to merge as quickly as we can, the staffs and organizations of our Northern Administration Branch with those of the Indian Affairs Branch in the north.

The Indian residents of the Yukon make up approximately 15 per cent of the total population and in proportion this is the largest Indian population of any province. I look forward to the day when the indigenous peoples of the North will participate more actively in government at all levels. The social, cultural, and economic advancement of this large group of Canadian citizens is of vital importance to our nation from many aspects and we must not only increase our efforts to achieve this, but we must seek ways and means of doing so at a quicker pace. I know that this will be no easy task and that solutions to many of the problems which exist today will not be easy to find. I cannot promise, therefore, any magical formula but I do undertake to devote a large proportion of my energies to this sphere and to encourage a dynamic approach which will not be afraid to introduce new ideas.

I should like to turn now to several matters concerning resource and economic development that are of particular importance and significance to Yukon residents. We have heard during the conference many excellent suggestions in this area and I assure you that I will look at these very carefully and will, wherever appropriate and reasonable, do my best to ensure that the federal government plays its full part. One of the factors that seems to have the closest bearing on the development of Yukon's resources is transportation. In this respect the Yukon is not unique - the hinge of our nation's future is economic transportation. The rails made us a nation - all of our progress depends on more efficient movement of people and material. Very often a potential resource project may go untapped for many years unless an efficient method of transportation at a reasonable cost can be developed. This has been raised during this conference and I think it is fair to say that the federal government is aware of the close connection between resources and transportation facilities and this awareness is evidenced by many positive steps we have taken in this regard.

As you know, we are at the moment rebuilding the first 37 miles of the Dawson-Boundary Road and paying two-thirds of the cost of a mine access road for the Clinton Creek property. I thought that $2.9 millions of aid was pretty generous - but some Yukoners wanted a $3 million bridge as well. The enthusiastic loyalty of the Yukon to which I have already made reference enabled your estimable Whitehorse Star to cry out in headlines Lack Scuttles Bridge." Can I give you a little advice - get a few more good properties in that area and you will get your bridge. In the meantime there are other important places to spend the money. The Watson Lake-Ross River development road is nearing completion and we will this coming summer, have two contractors working on the Ross River-Carmacks Road. I have kept in close touch with the principals in the Vangorda area which promises to be a tremendously important mining venture in the Yukon, and they are agreed with our view that the rate of construction of the Ross River-Carmacks Road is entirely adequate and that to attempt to speed up as has been suggested on some occasions, would neither be practicable nor warranted economically at this time. A ferry will be installed at Blind Creek which would be the best location for the Anvil project and the other mining ventures in the Vangorda area rather than at Ross River. The

possibility of either improving the Canol Road toward the Yukon-Northwest Territories boundary or the possibility of re-routing part of this road via Blind Creek is now under consideration.

It has been suggested that a bridge may be required across the Pelly River, in addition to the plea for the bridge across the Yukon River at Dawson. Both of these proposals have some merit and were we able to dip into a limitless source of funds, they could be built. However, there must be some order of priorities given to these capital works. The supply of money is not inexhaustible. They cannot all be built at once. We could very well have spent three million dollars on the Dawson River bridge and delayed the construction of the Ross River-Carmacks Road, but I am sure you will agree that that would not be any solution to the problem, and in solving one would only create another. The problem of spring thaw and winter freeze-up at Dawson has been recognized, however, and we are, at the moment, discussing with Cassiar Asbestos the possibility of building an aerial cableway that would be able to handle the large loads of asbestos fibre that must be shipped during these periods. In addition to the provision of transportation facilities for the two projects I have just mentioned, we are also considering carrying the road system westward from Carmacks to the Alaska Highway and we would also like to see the Dempster Highway taken right through to Fort McPherson. This could very well be the first permanent road link north of the Arctic Circle connecting the Mackenzie Delta and Northern Yukon with southern Canada.

A source of major concern to the Yukon throughout its history has been the problem of improved access to the outside world. Long before the Alaska Highway was built, the main route to the rest of Canada was via the sea. The Alaska Panhandle has always been viewed as a barrier by Yukon residents - it lies between them and the sea and this has been a factor in shaping the course of their trade, growth and development. The panhandle was first effectively bridged by transportation routes at the turn of the century when prospectors from all over the world rushed into the Klondike in search of gold and personal fortune. A railway was built between Skagway and Whitehorse via the White Pass, one of the easiest mountain passes, and this railway, as you all know, still continues to render valuable service today. The next permanent route built through the panhandle

was the Haines Road, built by U.S. Army engineers during World War II, and this is virtually where developments have stopped.

The question of transit across the Alaska Panhandle has attained its greatest prominence during very recent years. The U.S. Battelle Report, prepared for the Alaska International Rail and Highway Commission, proposed that overland routes might be carved into the Canadian interior from the Wrangell-Petersburg area, and also from Juneau. Mining discoveries in Canada behind the panhandle have led to other enquiries concerning access to the ocean and thence to world markets. Our Alaskan neighbors are vitally interested in the question of corridors. The Alaska state legislature within the past year passed a resolution concerning the construction of the proposed Skagway-Carcross Road.

The Canadian Government is interested in the question posed by the problem of access to the sea from many points of view. You may recall the announcement made by the Prime Minister at about this time last year concerning studies of the access problem. I elaborated on the Prime Minister's statement, subsequently, saying that the study was a preliminary one which had the purpose of providing the necessary background for inter-departmental review. I am sure many of you have wondered, since that time, about our findings and what subsequent actions might have been taken.

We learned that the problem of access to the sea is indeed complex. We considered matters such as the physical character of the panhandle region, resource endowment and potential, settlement and land use, forms which additional access might take, and the many political and legal problems arising out of the existence of the Canada-Alaska boundary. As our work has progressed, it has become increasingly apparent that only a few routes or facilities warranted further attention. There are many possible routes through the panhandle, but for a variety of reasons - economic; geographic; or engineering - many can be ruled out as being impractical without much study. Some, however, are truly deserving of a very close look, and could conceivably become the subjects of joint development by Canada and the United States if the necessary groundwork were laid.

One route which is deserving of further study is not one which would open a new corridor. I am thinking of the proposed Skagway-Carcross Road. My officers have been instructed to make a study of the economics of this route, and in so doing they will consider all relevant matters on both the

benefit and cost side. Concurrently with the work of my Department, the Department of Public Works is conducting an engineering study of the proposed road.

Another route which I think may legitimately be discussed within the framework of access to the sea, is the Haines Road. It is this year in which the federal government will have to make a decision on whether the road is to be kept open during the winter from now on. I cannot, without consulting my Cabinet colleagues, say whether or not it will be kept open, but I might make a few observations. I know that some people have had misgivings about keeping the road open during the past three winters on grounds that much of the traffic moving on it is Alaskan traffic. I am sure that no one, including the people of Alaska, has any illusions about who is the primary beneficiary of keeping the road open on a straight head-count basis. I believe that during recent winters, about three U.S. vehicles have moved on the road for every Canadian vehicle.

However, lest we in this part of Canada start thinking in terms which are too parochial, let me put the matter in these terms. Many of us are wont to think in terms of more routes to the sea through the panhandle. We forget, however, that the Haines Road is, in fact, vital to the Alaskans in terms of inter-Alaskan traffic. I think there is at least some case for believing that the people of Alaska, and also the United States Government, may be more interested in what we may some day have to say about access for our own purposes if we can point to an access route which has been maintained largely for their benefit through Canadian soil.

I shall now leave the many questions concerning access to tide water and turn to another matter having to do with transportation to and from the Yukon, and the question of the paving of the Alaska Highway. You are all aware that the federal government has had this matter under particularly intensive study during the past year or so. The Department of Public Works has conducted a thorough engineering study and has calculated the probable costs of undertaking the project assuming a number of alternative plans. My Department has had the Stanford Research Institute conduct an economic study and this study is now in our hands. It has been conducted with a great deal of professional skill and competence. I know you will want to examine the conclusions and recommendations yourselves and it is therefore our intention to have the text of this study published as soon as it is possible to do so.

Eventually, responsibility for maintenance of the highway will be transferred to the Territorial Government. It had been our intention to do this by April 1, 1967. This in itself is a major undertaking and, in the context of possible recommendations by a proposed advisory commission affecting the organization of the Territorial Governmental structure and other suggestions arising from the economic study it seems wise to delay this move for about a year. I have consulted with my colleague, the Minister of Public Works, and he is in full agreement.

The efforts of my government to improve and expand the economy of the Yukon will not be restricted only to road building. You have heard, no doubt, that we are in the process of commissioning a feasibility study in connection with the establishment of a smelter in the Pine Point area. We are going to be equally as interested in knowing if the aggressive exploration work now going on in the Vangorda area, produces reserves sufficient to support a smelter. And if we can assist in pushing forward such a major industrial expansion by a similar study I assure you the funds will be found.

Increased investment by industry is certainly welcome and I hope that there will be no hesitation to increase such investment in the future. There are, however, certain areas where the government can provide leadership, assistance, guidance, or ideas and in the future, we will not be backward in doing so.

The possibility of a smelter is but one project that may require further investigation. Others would be the use of coal and gas for thermal generation in the Territory and the development of hydro electrical energy. The Northern Canada Power Commission of which my Deputy, Mr. Côté, is Chairman, has just recently undertaken a study to assess the resources of hydro power potential available for use in the Vangorda area. This study will include our appraisal of the possibility of a thermal power development based on the Carmacks coal field. We will work closely with industry in this region and I am confident that the Government will authorize the Northern Canada Power Commission to proceed with the development of power to supply this exciting new mining development where the requirements and most suitable power source have been definitely established. The Northern Canada Power Commission is now proceeding to meet the problem of continued

supply of electricity and water service in Dawson City. Negotiations will shortly be underway with the Yukon Consolidated Gold Corporation aimed at taking over and improving the present facilities which exist for this purpose. My government has approved an advance of $600,000 to the Commission for the purpose of building a diesel generating plant and a new ~~electrical power~~ WATER distribution system. The amount relating to the power supply facilities, being half the advance, will be recovered in the usual manner through the sale of electricity, and the other half will be regarded as a grant to the Yukon Territory for the water system. The cost of electricity at Dawson should be significantly reduced once this new power plant goes into operation.

The potential not only for hydro energy in the Yukon but also for supplying fresh water to other regions is tremendous and we have heard something of this during the Conference. Certainly, we must regard water as one of the prime resources of the Yukon - one which I predict in the future will be of equal, if not of greater importance than the mining industry. But, we must make haste with care or otherwise we may find that this tremendous resource has been irrevocably committed to a series of projects which may not be in the long term interests of either the Yukon or Canada as a whole. It is clear even now that the Rampart Dam Proposal and the North American Water Power Alliance proposal are not entirely reconciled. They both want to use, in part, the same source of water and this source happens to be in the Yukon. The eagerness of the proponents of two such tremendous projects to advise Yukon and Canada how to use its water is, if nothing else, at least a good measure of the value of this resource.

Any discussion of resources would not be complete if it did not include the subject of our forests. Paralleling the increasing importance of the nation's water supply is the increasing demand upon Canada's forest resource. I have been told by experts in the field that the demand upon Canada's forests for the manufacture of pulp and paper, lumber and plywood will, within ten years, be doubled and within thirty years will be five and one half times what it is today. These same people tell me that if the forests of the ten provinces are to provide wood in perpetuity they can only support an increased demand of approximately four times today's production. Thus it becomes evident that within a few years the forests of the southern Yukon

will be playing a very real part in helping to provide the source for Canada's forest-based industry.

Tourism is another area where more immediate action can be taken. I have been impressed by the work done by the Territorial Government in this regard which I believe, has placed the Yukon and its attractions before a very wide range of vacationers on the North American Continent. Consistent effort will pay increasing dividends in the future. Although there are already many attractions for the tourist in the Yukon, I think you will agree more can be developed. In addition, adequate tourist facilities must be provided if the vacationer is to go away with pleasant recollections of his stay. I have been told that many campers are particularly complimentary about the government camp sites along the Alaska Highway and I know that efforts are being made to increase these attractive resting places.

One thing the Yukon does lack is a National Park. Even though I recognize there is an apparent conflict of interest between those who would like to conserve wildlife and preserve the wilderness scene and those who want to search for and exploit the mineral wealth of the Territory, there surely must be some common meeting ground.

In my experience, there are few activities of man more challenging or interesting than the search for the hidden wealth that lies buried within the earth and I recognize that this search must be wide-ranging and as far as possible look into all potential areas. But National Parks are resources too. While their primary purpose is conservation, they provide employment and tourism as well - and they don't run out of ore after a few years! We have at the conference heard a great deal about the best ways to utilize the Yukon's natural resources to further the social and economic conditions of the Yukon. In this we have tended to overlook one important aspect of resource development. In an area where, because of the geographic and climatic conditions, some activities are difficult to encourage, I do not think you can afford to overlook one, ever present, that has good merit for the future. I, therefore, recommend to you most sincerely the establishment of a national park in the Yukon and suggest that you might wish to pursue this objective with the same vigour that has been displayed in the organization of this conference.

Before closing, I should like to talk about the need for closer co-operation between the two levels of government to ensure that on the

one hand we, in Ottawa, have an even better understanding of the requirements of the Territory and are thereby in a better position to recommend or assist projects that will benefit the region. Equally as important, you who live here will understand some of our problems and not feel that Yukon matters sit forever in the pending basket. I think the ground work for this co-operation which we all seek is being well laid.

For example, in the field of mining, we have an extremely useful and productive working relationship with the Yukon Chamber of Mines. The advice of this organization in respect to the administration and management of minerals in the Territory is most helpful at all times. In recognition of this, and to enable the Chamber to further its work, my colleagues have agreed that the annual grant should be doubled from $2,500 to $5,000. I have met with the President, Mr. Paul White, and some of the members during my stay here and we have discussed mining matters of mutual interest. As I think many of you recognize, the administration of mining in the territory is carried out under the direct supervision of the Commissioner and it is only rarely that any matter is referred to me or my staff in Ottawa. There has been one important exception to this up until now, and that is the processing of mineral leases. This was handled in Ottawa but, in accordance with our policy of bringing the administration of such matters as close as possible to the public we serve, the Commissioner has now been authorized to prepare and execute all such leases. This, I am sure, will eliminate some delays and will enable the applicant for a lease to talk directly to a member of my staff in the Yukon who will be handling the matter.

On this same theme, I should also like to mention the very useful contact and association that is developing between myself and members of my department and the Yukon Research and Development Institute. This group of dedicated residents who are sincerely searching for ways and means of identifying methods of improving the economy of the Yukon, have already been of considerable assistance and I look forward with keen anticipation to receiving from them new ideas and suggestions in the future.

The exciting prospects and challenging possibilities of the future are going to require a great deal of hard work from everyone. I shall have to continue to rely very heavily on the support of my staff here in Whitehorse and at other centres in the Territory to keep me informed and advised what part we, in Ottawa, can play in the future. It was, therefore, with very deep regret that I learned that your Commissioner, Gordon Cameron, had decided to leave the Yukon and that he would not be able to continue as

Commissioner after June 1st. Gordon's twenty-five years spent in the Yukon during which he worked on many varied aspects of local industry, particularly in the fields of transportation and mining, plus his experience as first Alderman and then Mayor of Whitehorse, have proved invaluable to both of us during the past four years. During his term as Commissioner the territorial administration has expanded a great deal and I think that Yukon residents should consider themselves fortunate to be served by this dedicated and hard-working group. I am always impressed when speaking to some of the people involved with the interest and enthusiasm they exhibit in the growth and development of the Yukon and I am sure much of this can be attributed to Gordon's dynamic leadership. He will not be an easy man to replace and I am sure that Yukoners will feel a very real sense of loss when he leaves the Territory.

I should, therefore, like this evening to publicly thank Gordon for everything that he has done during these years since I am convinced that he has played a very large part in laying the ground work for expansion and improvement in the future.

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# PAVING OF ALASKA HIGHWAY KEY TO YUKON TOURIST POTENTIAL

PRESENTED TO

YUKON NORTHERN RESOURCES CONFERENCE

Whitehorse, Yukon

BY

CHARLES B. WEST

March 24, 1966

"PAVING OF ALASKA HIGHWAY KEY TO YUKON TOURIST POTENTIAL"

By

Charles B. West

Yukon Northern Resources Conference

Whitehorse -- March 23-25, 1966

Our two countries have adopted individual programs for the encouragement of our respective citizens to travel at home this coming year. "Discover America" is an organization set up by Presidential directive to promote the idea of seeing America first before leaving our shores for foreign lands. The idea behind this promotional effort is to somehow restore the balance of payments between the USA and the rest of the world. Canada, through the Canadian Tourist Association, is following the same theme and for the same purpose. "Know Canada Better" will be the identifying slogan for this movement. According to a recent report from the head office of the Canadian Imperial Bank of Commerce, current expenditures by tourists and travelers in Canada is between 2 1/2 and 3 billion annually. Travel receipts are estimated to be Canada's third largest earner of foreign exchange, ranking after wheat and newsprint, and are about half as large as all exports of fully manufactured goods.

To a large extent, domestic travel and travel abroad compete, and in the same way that attempts are being made by both Canada and the USA to reduce imports by encouraging the buying of Canadian-made and American-made products, a campaign is under way to encourage our people to stay at home.

We have here an unusual opportunity to join hands and work together toward the same goals. In the 1962 Conference of the Pacific Northwest Trade Association, which I attended, the idea of promoting an area rather than individual states or provinces was proposed under the "Common Market of Travel" theme. Much progress has been made since that date, and today we find Oregan and Washington cooperating with British Columbia in advertising nationally in major publications: "Make yours a two-nation vacation!" Here illustrated is a tremendous example of joint effort in selling a common market. Why not expand this idea to include Alaska and the Yukon? Certainly, with our areas as magnets, travel through the other more southern portions of the Pacific Northwest and B.C. will be automatic. Tourists will have to travel twice in and out of the contiguous areas to reach our more northern vacationland.

The Battelle Memorial Institute, which made the only comprehensive survey on the tourist potential of Alaska and the Yukon, reported that "depending upon the improvement of transportation facilities, Alaska and the Yukon may expect 850,000 visitors by 1980." Of primary importance to the accomplishment of this goal is the paving of the Alaska Highway. Since the date of the Battelle survey, we have seen the development of the State of Alaska's Marine Highway System, connecting at Prince Rupert with the Alaska Ferry System. There is no question at all that the Canadian and American tourist is attracted to the idea of vacationing in Alaska and the Yukon. I was present at the Prince Rupert meeting last fall when Premier Bennet stated that the "Queen of Prince Rupert" was just the first of the ferries to be built for the run to connect Vancouver Island with the rail and highway head at Prince Rupert. He further stated that B.C. would be willing to pay one third of the cost of paving the Alaska Highway. I am reminded of the story of the fellow who crossed a parrot with a tiger. When asked what kind of a beast he had created, he said: "I don't really know, but when he talks, you'd better listen!" I think we all had better listen to Premier Bennet -- not only listen, but do our part to see that interest in travel to Yukon-Alaska is not left wanting due to failure to get our respective governments together on the important job of paving this vital tourist artery. The completion of the new Trans-Canada Highway, the increase in private-car registrations in Canada, the high level of prosperity evidenced in all of Canada combine to offer an unprecedented potential for attracting Canadian vacationers into making a triangle

tour across Canada to Vancouver Island, thence to Prince Rupert and on into Alaska and the Yukon, with a return over the length of the Alaska Highway. The greater number of these dollars will remain on your side--in Canada. "Know Canada Better" will become more than just a theme--it will be a reality to all who make the trip.

What about adopting a slogan which combines the purpose of "Discover America," "Know Canada Better" and the common market idea: "Make yours a two-nation vacation in Northwest North America" or "Visit Northwest North America"? When asking a person to describe just where NNA is located on the world map, he would adequately reply: "It's up in the upper left-hand corner of the Northern Hemisphere." That is NNA and we all share in the common desire to see more Canadians and Americans spending their vacations visiting this part of the Hemisphere.

Tourism must grow in balance. This means that facilities must grow in proportion to demand. Transportation, hotels, sightseeing are the major ingredients in a tourist industry. One segment cannot move too far ahead of the other without developing an imbalance. This creates problems until corrected. An example here in the Yukon of this situation was the necessity for my company to purchase and then modernize and expand the lodge facilities at Beaver Creek. Alas/kon Border Lodge became a necessity when our bus tour volume developed until it could not be handled at any one point on the highway between Whitehorse and Fairbanks. Another example is the Yukon situation as it is on the path of travel to and from Alaska and can become a "bottleneck" should tourist housing not keep pace with the growth of travel.

It is my positive belief that the year 1966 will be the biggest in the history of the Yukon-Alaska tourist industry. The impact of the new Kelsey Bay ferry will be felt along with the growth resulting from an increased awareness on the part of the traveling public of the attractions which abound in this wonderful country. Transportation companies, tourist organizations and tour companies such as our own are increasing their advertising budgets, all of which adds to the stimulus for travel into Northwest North America. We must guard against overpromotion as carefully as we would against apathy and underselling our areas. Until facilities are available at key points in sufficient quantity and quality--and I wish to emphasize the word "quality" at this point, as it is most important not to offer sub-standard facilities--at any time--anywhere-- or we cannot take full advantage of the existing potential from our new Marine Highway service. The day the Alaska Highway is paved the real bonanza of tourism will be realized. Ma and Pa and the kids are the real tourist potential for Alaska and the Yukon just as they have been proven to be the biggest source of travel dollars in lower Canada and the USA. Tourism, like other business activities in a free competitive economy, prospers when the visitor finds his vacation enjoyments are in reasonable relationship to the costs involved. What are these benefits or enjoyments? What are the costs and how can they be measured in order to evaluate the attractiveness of a vacation in the Yukon and Alaska as compared with some other area? How does the toruist assign monetary values to a view of Mt. McKinley or Mt. Logan--a visit to Robert Service's old log cabin--a ride on the Yukon River or some other spiritual, mental or physical experience? The conclusion follows that it behooves Alaska and the Yukon to provide high quality tourist objectives and to efficiently promote them with a continuous dynamic and intelligently perceptive program.

It is my privilege to be a member of the International Highway Paving Committee, dedicated to completion of the Alaska Highway paving. I've also been serving as Acting Chairman of the Alaska Committee of the Seattle Chamber of Commerce. At our last meeting in Seattle on March 15, where we were addressed by Mr. Monty Aldous, General Manager of the British Columbia Ferries, I had the opportunity to present a Resolution, which was unanimously adopted, urging the immediate consideration by the Governments of Canada and the United States of paving the highway link through British Columbia and the Yukon, connecting Haines

with Interior Yukon and Alaska. As you know, Haines is the terminal point where the highway joins the main highway system from Canada and Alaska. The portion from Haines to Porcupine, 40 miles north of Haines, is presently paved. This Resolution calls for the immediate paving of the portion extending from Porcupine to the Alaska-Yukon Border and, as well, the paving of the highway from Whitehorse to Haines Junction. The surfacing or these routes, which involves substantially less mileage than the southern highway, would provide for all service travel from the West Coast of North America all the way to and from Alaska. People then could drive in a straight line from Mexico to Fairbanks without ever being off of paved roads. The triangle to be paved from Porcupine to the Alaska-Yukon Border and to Whitehorse would enable passengers to travel into and from Alaska and the Yukon without using the same route twice. Passengers could travel in their own cars through the Whitehorse Gateway in one direction and Haines the other, or vice versa. The paving of the southern portion could then be accomplished in due course. Meanwhile, the traveler could be induced to move over the ferry systems of Canada and Alaska with the knowledge that he would not have to face the dust, rocks and hazards of unsurfaced roads when traveling beyond the ferry systems. In speaking of the potential for tourism in the Yukon, I sincerely feel that the attraction of advertising paved highways into the Yukon and Alaska is going to have a significant impact on the saleability of these areas to Mr & Mrs John Q. Public. With Whitehorse being the capital of the Yukon and the center of tourist interest, certainly this fact will be of great concern to business and government leaders in this area.

It would be encouraging if from this meeting a similar Resolution to that of the one voted in Seattle could be approved, giving support which is needed before governmental action can be forthcoming. Being a citizen of the United States, I fully realize the roads to be surfaced belong to Canada and that we in the States should wait to be asked before offering our help. It might seem somewhat presumptuous for us to suggest this action to our Canadian friends I do sincerely believe, however, that this meeting here in the heart of the Yukon on the terminal point of the Alaska Highway would be an excellent place to initiate support for the idea presented in this Resolution. Could not the Northern Resources Conference take action on this important issue? The future of the Yukon and Alaska tourism is at stake. I hope that this meeting will be productive and that we'll not remember it as just another of those Conferences which, when summed up, was just "Talk - talk - talk" and "Pass the Resolution"! Let's not all go home and forget the resolve which we felt while meeting here together. We'll need to work together positively for our common interests. This work should continue beyond this meeting and be carried to fruition and completion. Only in this way may our goals be achieved.

Just as the conquest of space is providing a new challenge with new opportunity to mankind in general, so the challenge of the North provides a peculiar Canadian and Alaskan challenge and a Canadian and Alaskan opportunity. Let us not miss our opportunity! Let us accept the challenge!

# BASE METAL SMELTING AND ITS APPLICATION

TO

YUKON MINERAL DEVELOPMENT

Presented to

YUKON NORTHERN RESOURCES CONFERENCE

WHITEHORSE, YUKON

March 24, 1966

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# BASE METAL SMELTING AND ITS APPLICATION

# TO

# YUKON MINERAL DEVELOPMENT

## INTRODUCTION

This paper is an attempt to outline some of the advantages a smelter industry would present to Yukon and to suggest some of the problems that may have to be overcome. No attempt is made to outline the economic feasibility of a smelter as this would require a systematic and detailed engineering and marketing study over a period of time. Preliminary studies of this nature have been made in the past by major metal producers and, indeed, a study is presently underway by a company active in Yukon mining.

Smelting, simply defined, is any process for the reduction of metals from their ores by some means that include fusion. Zinc retorting, although commonly referred to as smelting, is not, because complete fusion of the charge does not take place. Hydrometallurgy likewise would not be considered as smelting as no fusion enters into the reduction of ore to its metal. For the purpose of this paper smelting will be considered in its widest sense and some reference to hydrometallurgy will be made.

## HISTORY OF BASE METAL RECOVERY PLANTS

Early development of the mineral industry in the west was based almost entirely on gold and silver. There was little interest in base metal deposits as there was no way to market the product. Gold was won chiefly from placer deposits. Gold and silver was later found in refractory sulphide ores which could not be treated efficiently by milling alone. Smelting was then established in the west to treat these ores and to recover gold, silver, lead and copper. In the early days zinc in complex ore was not recovered and an ore with a high zinc content could not be marketed.

Early western smelters were nearly all custom plants, who obtained their ore and concentrate from independent mining operations. A successful smelting enterprise requires a complex installation of costly facilities and equipment and an assured ore supply for a period long enough to amortize the cost of construction. In the early stages no one mine could furnish an adequate ore supply and a single smelter served many mines.

Initially, smelters did not enter into the mining field, however as supplies of ore diminished some were forced into mining in all its phases in order to stay in business. Many smelters in the past did not survive as their operations were not based on sound economics or reliable ore supplies. For many years the trend has been towards fewer and larger smelter complexes.

## GENERAL

The reason for establishing a primary smelting industry in Yukon could be economic, social, political, or a combination of all three. The social and political implications of Yukon smelting are far reaching and for this reason have captured the public imagination. Smelter construction should be considered within a broader plan of economic development and as a possible key to diversified metalliferous and manufacturing industry. The establishment of a successfull smelter complex in Yukon with its related secondary industries would not only greatly assist the development of Yukon mineral resources but would also stimulate the overall economy and quicken the march towards provincial autonomy.

The prime object in establishing a smelter complex in Yukon should be economic and with the purpose of producing a product that can compete on a world market. The main stimulant to location and construction of smelter facilities has been markets rather than resources. The present day close competition in world markets usually tend to channel the trade along economic lines.

The prerequisites necessary for the successful establishment of a smelter complex in Yukon are many, some of which are:

a) Mineral Resources
b) Power Source
c) Coke Source
d) Transportation
e) Markets
f) Labour and Management

These factors will dictate the type of smelter complex applicable, and will be discussed under their various headings.

RESOURCES

Yukon mineral resources, relatively speaking, are only just starting to be developed. This subject is being more completely covered in another paper being presented to this conference. The pattern developing would indicate that Yukon has an abundant supply of lead and zinc containing silver. Copper and nickel ores occur in lesser amounts. Any remarks made regarding the smelting of lead and zinc would also apply generally to other deposits of base metals should ones of sufficient tonnage potential be developed. Past and recent developments in the Vangorda area plus known deposits in the MacMillan Pass and Watson Lake areas suggest that a sufficient tonnage of lead-zinc ores may exist to supply a smelter complex. Copper and nickel occur in the southwestern Yukon in possible commercial amounts, however the tonnages developed to date are relatively small in terms of a smelter establishment.

POWER

Papers are also being presented to this conference on both Hydro and Thermal Power. Hydro power is available at many Yukon localities in sufficient amounts to supply both domestic and commercial markets. The harnessing of available hydro power could be made economic if the use of large blocks of electricity by a smelting industry were assured. Modern technology regarding transmitting of power from source to consumer has advanced to the point where a central Yukon power source can be considered. Recent developments in the generation of thermal power should focus attention on the coal resources of the Carmacks area. At this locality a large quantity of relatively underdeveloped high volatile bituminous coal exists. The utilization of this source of thermal energy should be studied with a view to supplying electrical energy for Yukon. A recent study of thermal plants indicates that the average busbar energy costs for thermal plants is in the order of 7 mills per net kwhr. Average construction costsfor these plants is about $127.00 per kw. Much will depend on the thermal characteristics of Carmacks coal and the cost of its extraction.

COKE

The processes of base metal smelting and of zinc distillation use large quantities of coke. Zinc in particular requires a large amount of metallurgical grade coking coal. Unfortunately there is no known coking coal in Yukon and therefore it would have to be imported. Coke can be obtained from the Crowsnest area of B.C. and costs about $10.00 per ton at mine head and is delivered to Vancouver at an additional cost of $5.00 per ton. To this $15.00 per ton the freight costs for delivery to the smelter site would have to be considered. Coke could be imported from other maritime countries.

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TRANSPORTATION

Transportation is a vital factor in determining the location of a smelter and its feasibility. In addition to the outbound tonnage of metal and by-products, there would be a substantial volume of inbound freight in the form of coke, flux, fuel and general supplies. In order for a smelter to compete in world markets it would be essential to have low cost transportation. There are factors inherent in a Yukon location, such as distance from markets, terrain and low density of population, which offer problems in attaining this low cost.

If the volume of freight moving in and out is large enough, the choice of a Yukon smelter location may necessitate an extention of the railroad beyond Whitehorse. Given the volume it has been proven that a railroad operation can attain the lowest overland transportation costs. This is the case in nearly all new mining developments in Canada where substantial distances and tonnages are involved. All existing Canadian smelters are served by a railroad. To make a railroad extension feasible, a mass volume of freight would have to be assured over a long period of years. The cost and advantage of all rail transportation to tidewater would have to be compared to the existing truck and rail facilities which would in turn play an important part in determining a smelter location in Yukon.

MARKETS

The most important consideration in determining the feasibility and location of a Yukon smelter complex is the nature and location of present and future metal markets. Ore reserves are important and a source of raw materials and power should not be overlooked, however these do not necessarily ensure a smelting and refining industry.

Many of the world's zinc smelters and treatment plants are located in regions where there is little or no zinc mining and conversely many zinc mining regions have no treatment facilities. It follows then that there is a considerable amount of international trade in zinc concentrates. U.S.A. has a large excess of treatment capacity which is met largely by imports of concentrate from Canada and Mexico with smaller amounts from Latin America. Japan is in much the same position. They are excellent metallurgists and they must continue to import large quantities of all base metal concentrates in order to keep their industries going. In Western Europe the countries that are deficient in zinc metal obtain their needs from Belgium, Norway and Italy. United Kingdom requirements come from Australia. In some cases world trade in zinc concentrate is influenced by part ownership of the mines by certain smelters or from long standing arrangements. International trade of zinc concentrate is greater than that of metal. Canada and Belgium are already the largest exporters of zinc. Lead discoveries in the Missouri area of U.S.A. have been spectacular and several new lead mines are in the making. It is expected that within two years, production of lead in the U.S.A. will be sufficient to supply domestic needs. It should be remembered that a mine selling a base metal concentrate is operating in a sellers market whereas a smelter selling a metal is operating in a buyers market.

MANAGEMENT AND LABOUR

The attitude of both management and labour are important. Management should be experienced men with a knowledge of world markets. Trained operators and technicians would have to be obtained. It would also be necessary to train and educate local management and labour both technically and generally in order to establish a successful smelting industry. Labour costs may be higher in Yukon than in the more industrialized sections of our country.

SMELTER TECHNOLOGY

The foregoing has suggested some of the factors that must be considered for smelter construction and the result of these considerations would dictate the feasibility and type of smelter complex to be built.

Any single smelter in the world today can do something that another smelter cannot by virtue of its location, particular facility, vertical integration, lateral integration, metal sales policy, proximity to fuel or power and for many other reasons. The field of base metal smelting is highly complex. To process lead concentrates or zinc concentrates, not just a smelter but a smelter complex is required. The same would apply to copper or nickel. The process for the reduction of lead minerals to metallic lead is relatively simple and consists of heating in a furnace a charge of ore or concentrate, roasted or sintered if necessary, mixed with fluxing material and added fuel. The heat may be supplied by coke, pulverized coal, gas, oil or in part sulphur in the ore. The products of lead smelting are base bullion, matte, speiss, slag, flue dust, fume and gases.

Zinc smelting (retorting) is a more complicated and costly process. It does not involve complete smelting or fusion of the charge so that it is not truly a smelting process but rather it is a distillation process. It involves the conversion of zinc sulphides to zinc oxide by roasting and sintering. The sintered material is then fired by fuel (usually gas) together with carbon (coke) in a retort furnace. Carbon unites with oxygen and metallic zinc is given off as a vapor which is condensed and collected. This process is completely different from lead smelting and takes large amounts of fuel and coke. Lead that is contained in a zinc concentrate or zinc contained in a lead concentrate is difficult and costly to recover. Each has to be separately collected, and shipped to its respective smelter.

A recent development and breakthrough in pyrometallurgy is of considerable interest to Yukon lead-zinc deposits. This process known as the Imperial Smelting Process (I.S.P.) was developed in England by the Imperial Smelting Corporation Ltd. This process employs the use of a blast furnace for the production of zinc, lead and copper. This blast furnace works at ordinary pressures and in a system which is able to condense a blast furnace gas of a very low zinc content. The only ore preparation necessary is bulk concentration and sintering of the feed to provide a porous furnace charge. Fluxing materials are added before sintering. Close control of temperature and gases within the furnace enables a zinc metal, formed as a vapor, to be condensed outside the furnace by a molten lead spray. The molten zinc-containing lead is cooled and zinc separates out. Simultaneously base lead bullion and even copper matte are produced this recovering in one operation and with one smelting cost, lead, zinc, copper, gold, silver etc. The cost of coke for the process is higher than for lead and copper smelting but less than in conventional zinc retorting. If the material charged to the furnace consists of sintered high grade concentrates it is possible to reduce about one ton of zinc per ton of coke consumed. This would represent a significant cost per pound of zinc produced depending on Yukon location of smelter. An I.S.P. furnace constructed at Swansea in 1960 was expected to burn some 106 tons of carbon per day as coke and was expected to produce 125 tons of zinc and 34 tons of lead per day.

I.S.P. is young compared with established smelting methods and further research will undoubtedly improve the process. It is fully competitive under general conditions for the treatment of high-grade concentrates. This process would be specially applicable in the treatment of complex lead zinc copper ores of the Vangorda area of Yukon whereby the lead, zinc and copper could be removed simultaneously. This process could also be adapted to custom smelting of lead-zinc ores.

The foregoing pyrometallurgical processes all require large amounts of coke and as the Yukon has no known deposits of coking coal the possibilities of hydrometallurgical extraction should also be considered. Hydrometallurgy consists of the extraction of metals from sulphide ores by wet methods. This method is particularly adaptable to zinc concentrates but can also be used for the extraction of lead from lead sulphide. The process is of particular interest in areas where low-cost electrical energy is available as opposed to high cost coke requirements. The process for zinc consists of roasting the concentrate to convert zinc sulphides to acid-soluble oxide and water soluble sulphate. The sulphur dioxide provides sulphuric acid needs for the leaching process. Either hearth or flash roasting is used. Weak sulphuric acid is used to dissolve zinc oxide and zinc sulphate. After residues are removed the solution is purified and stripped of zinc by precipitation or electrolytic means. Lead can likewise be extracted by hydrometallurgical processes similar to zinc by Amine Leaching, however further research may be necessary to make the method commercial.

In addition to the smelting or reduction of concentrates to their respective metals, markets may dictate a further processing or refining of the smelter product. This would require in addition to the construction of a smelter complex the further construction of a lead and zinc refinery.

With the production of metallic products from a smelter complex there is a large quantity of gases produced. Formerly it was necessary to construct smelters in isolated areas because of the destructive action of smelter gases on the countryside. Today we must consider not only the local conditions but the world atmosphere. Removal of toxic materials, chiefly sulphur, is almost a must in this day and age. This problem has led to the establishment of important by-product industries related to major smelting companies. These industries consist of fertilizer, sulphur, iron and sulphuric acid manufacture, and have turned a detrimental problem into an asset. They also, to some extent, control both the production and the economy of the smelter. Careful consideration must be given the location of a Yukon smelter complex so as to be able to utilize these by-products economically otherwise the industry may be saddled with a costly problem rather than an asset as at other smelters.

SUMMARY

A smelter complex located in Yukon and serving Yukon mineral deposits in both socially and politically desirable. Extensive engineering studies are required to determine whether a smelter complex is economically feasible and, if so, to determine its most advantageous location, particularly with regards to custom smelting. A smelting complex must purchase concentrate or ores from the mine or mines, smelt the concentrate, refine the resultant metal, and deliver the refined product to market at a profit. The metal delivery costs vary widely amongst smelters depending upon their location and proximity to large marketing area. If a mine is adjacent to a smelter which is adjacent to a refinery which is adjacent to a market its orebody may be considerably upgraded.

Metal recoveries and smelting and refining costs for a given smelter are closely guarded secrets because, unlike mines, smelters must compete much of the time with other smelters. This is especially the case with custom smelters.

Smelting base metals is essentially a manufacturing operation. It obtains its profits, if any, from processing and refining of ores and marketing the resulting products. In this respect the industry is in direct competition with world producers and therefore the economics of an operation become of major importance.

This paper has presented a brief discussion on some of the more important factors concerning the construction of a Yukon base metal smelter. These factors in order of importance are:

a) Availability of metal markets both present and future

b) Cost of coke and/or electrical energy

c) Availability of mineral resources

d) Utilization or cost of waste and sulphur disposal

e) Cost of transportation

f) Knowledge and ability of management plus the cost of labour

g) Availability of capital and volume of production necessary to amortize this investment.

A complete economic study of the above factors must be made and the cost compared to that of the production and shipment of seperate concentrates to their respective smelters or the possibility of producing and shipping a bulk concentrate suitable for Imperial smelting Processing.

Government policy could somewhat modify the economic situation by the implementation of such techniques as tax incentives and bounties.

It is the sincere wish and desire by all those associated either directly or indirectly with Yukon mineral resources that Yukon in the not too distant future will have an integrated metalliferous industry based on the operation of a profitable smelter complex.

REFERENCES

1. Salsbury, M.H., Kerns, W.H., Fulkerson, F.B., Bramner, G.C., Marketing Ores and Concentrates of Gold, Silver, Copper, Lead and Zinc in the United States, Bureau of Mines Information Circular 8206, U.S. Dept. of Interior, 1964.

2. Buck, W. Keith, Mineral Development Policy, Mineral Information Bull. MR 64, Mineral Resources Division, Dept. of Mines and Tech. Surveys, Ottawa, 1963.

3. Morgan, S.W.K. and Lumsden, J., Zinc Blast-Furnace Operation, Journal of Metals, April, 1959.

4. Morgan, S.W.K., Zinc Blast-Furnace Technology, Journal of Metals, January, 1964.

5. Long, Carleton C., Josephtown Smelter, St. Joe Lead's Electrothermic Zinc Plant, Journal of Metals, December, 1965.

Forward, F.A. and Warren, I.H., Extraction of Metals from Sulphide Ores by Wet Methods, Institute of Metals, London, England, September, 1959.

7. Electrical World, 14th Steam Station Cost Survey, October 18, 1965.

8. Forward, F.A., Veltman, H. and Vizsolyi, Production of High Purity Lead by Amine Leaching, International Mineral Processing Congress, April 6-7, 1960.

Elver, R.B., James, T.H., and Walsh, J.H., Technical and Economic Factors in the Choice of Steel Plant Locations, Mineral Information Bull., MR 66, Mineral Resources Div., Dept. of Mines and Tech. Surveys, 1963.

10. Lewis, C.J., Drobnick, James L., Some Chemical Techniques for Metals Mining, A.I.M.E., Preprint No. 63B317, 1963.

11. Neelands, R.E. and Fraser, D.B., Zinc in Canada with Comments on World Conditions, Mem. Series 137, Mineral Resources Div., Dept. of Mines and Tech. Surveys, 1958.

# DEVELOPING MINES IN THE NORTH

Presented to

YUKON NORTHERN RESOURCES CONFERENCE

Whitehorse, Yukon

By

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Carmacks, Y.T.

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"DEVELOPING MINES IN THE NORTH"

Foreword

The ideas and data that I have assembled for this paper are to a large extent the experience of the Byrne group of mines over the past few years and mainly in the North West Territories.

I have attempted to present this material in a form that may be of interest to the layman, and at the same time provide some ideas and figures that may be of value to others engaged in Northern development work.

These remarks are of course events and factors influencing northern development as seen through the eyes of the small operator.

Introduction

This place on your program was originally scheduled to be filled by Mr. J.C. Byrne, the President and Managing Director of Discovery Mines and the operating head of the Byrne Group of Mines. It is regrettable that due to pressure of other business Mr. Byrne was unable to be in attendance at this conference since, due to his extensive experience in developing and operating mining properties in the North he is well versed in this subject.

His introduction to the North came early, during his University years when Jerry, with his brother Norman and two prospectors, sailed down the Mackenzie River and spent a season engaged in exploration along the north shore of Great Bear Lake. This introduction to the North must have made a profound impression on Jerry because his career from that point on has been largely Northerly oriented.

In the late forties the Byrne family drive and knowledge of Northern operations were largely responsible for the success of Discovery Mines Limited, in becoming Canada's most northerly gold producer. The successful development of this property was followed a few years later by bringing Rayrock Mines Limited into production as the only Uranium producer in Canada financed without recourse to a bond issue. Perhaps one of the toughest problems in Northern mine development was that encountered in bringing Rundra Mines into production by the combined efforts of Discovery Mines and New Dickensen Mines.

Trends in Exploration and Financing

The nature of the geography of Northern Canada, where so much of the land area has been stripped clean by glacial action, or where the country is covered by lakes or muskeg, makes the use of the older tools of prospecting largely impractical. Thus we have few stream beds serving to show the way to mineral deposits by gold or sulphide concentration, or by trails of mineralized float left along the hillside as was the case in many of the early discoveries in Southern Canada.

Mine finding in the North thus comes to depend more and more on the newer tools of prospecting such as airborne magnetometer surveys, ground geophysical methods, geochemical testing and detailed geological mapping. This type of work all requires expenditure of large amounts of money so that future development in the North will depend on the efforts of the exploration companies and syndicates rather than on the efforts of the individual prospector. Ground prospecting still has its place on any exploration program but for reasonable hope of success should be utilized in conjunction with these other more scientific methods.

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Development Programs

The development of the main Discovery Mines is a rather interesting example of mine finding in this type of country. Regional mapping by the Geological Survey of Canada outlined a compaaratively small body of meta volcanics situated in an extensive area of Precambrian sediments. Encouraging results at the Giant Yellowknife Mines in 1943 and the following years had indicated the possiblilty of gold mineralization within the volcanics, so that the volcanic body near Discovery was staked and an exploration program commenced.

Norman W. Byrne, a Consulting Mining Engineer resident in Yellowknife was retained to supervise this exploration work and as part of this program he instituted surface prospecting of this group of claims. A local prospector Waggenitz was set to work on this project and in the fall of 1945 he located a quartz exposure showing some visible gold in the sediments adjacent to the volcanic contact. Little did he realise that at that monent he was standing on a pipe like quartz vein that, with one major fault offset, extended downwards at least 4,000 feet and contained over half a million ounces of gold!

By 1948 the ore zone had been developed by a vertical shaft and openings on two levels to a depth of 350 feet with sufficient ore reserves indicated to warrant the installation of milling equipment. With limited finances available a used milling plant was acquired and with time the essence of the program, this mill en route to the property went to the bottom of Great Slave Lake in a shipping disaster.

A frantic search for replacement equipment proved successful when the plant installed at Cariboo Hudson Gold Mines, 20 miles east of Barkerville, was acquired. This was dismantled and shipped in record time by truck to Prince George, rail to Grimshaw Alberta and by truck to Hay River, N.W.T. It was a photo finish, and the trucks carrying this equipment reached Hay River with only hours to spare before the last barge for the season cast off! This material was transported to the mine that winter and construction proceeded the following season.

About the time that erection of the mill started, further downward development disclosed the rather disconcerting fact that the ore zone had disappeared - cut off clean by a major fault. This geological catastrophe brought forth numerous theories with a fault movement suggested up to 1200 feet. It was here that once again some of the unsung heroes of the mining iindustry demonstrated their worth when the mine geologist worked out a movement of some 200 feet. Downhole drilling was commenced to test this theory, and when the first hole brought up a dandy intersection at the right location, it is reported that the mine manager of that day rapidly arranged a small plane and bore the core triumphantly to Yellowknife for all to see. This momentous occasion was toasted generously before the night was out!

From that point on "Discovery" has had a very happy life and is now in its 17th year of production. During this time nearly 890,000 ounces of gold with a gross value of over 31 million dollars has been produced. The mine commenced operations with a diesel plant but after a couple of years of operation the future looked sufficiently promising so that a power line was constructed to tie Discovery in with the hydro power available from Northern Canada Power Commission. In 1953 this line, a 33,000 volt single pole line approximately 40 miles to Discovery was completed at a cost of about $8,000 per mile.

Operating at Discovery has not been entirely without its problems, which to date, have all been solved. The most serious problem we have encountered is caused by the presence of methane gas in the sediments at the lower elevations in the mine. There have been four serious explosions from this cause, 3 of which resulted in fatalities. Extensive ventilation and vigorous education of the underground crews have been successful in lessening this hazard. As might be expected in a mine extending down to 4,000 feet rock pressure has become a minor problem on the lower levels. A switch to cut and fill methods and more support has pretty well overcome this disadvantage.

On the brighter side, a round the headframe at Discovery has grown a happy thriving community over the years. There are now over 30 families resident in the community as well as the single male population. Facilities available here include a school, post office, recreation hall, curling rink, heated outdoor swimming pool, steam heated housing and a magnificent lake for fishing and boating.

The second successful venture for our organization in the Yellowknife district was Rayrock Mines, which rode to fame during the uranium boom of the mid fifties.

The initial surface showings here were located by ground traversing with the gieger counter. Diamond drill investigation of these radioactive surface showings indicated a substantial tonnage of uranium ore. Underground development work corroborated the drill information and in very short order the property was linked with Great Slave Lake by 30 miles of road, serviced by a 20 mile power transmission line from Snare Hydro plant and equipped with an ultra modern uranium leaching plant.

Rayrock was a very high grade deposit and although of fairly short duration was quite successful nonetheless. This company continues as a diversified holding company and also a very active exploration company.

No story of mine development in the North would be complete without a chapter on Tundra Mines situated as it is well out into the barren lands and 150 miles from the nearest supply centre and year round transportation.

The ore occurence at Tundra is somewhat similar to Discovery in that it is a gold bearing quartz vein in a precambrian greywacke located near a sizable body of volcanics. However, due to the location, the physical handicaps to be overcome were plentiful.

The property was originally owned by Bulldog Mines Limited and during their operation surface diamond drilling confirmed the downward extension of these surface showings. No further work was done until the property was re-organized and financed by the efforts of Discovery Mines, New Dickensen Mines and Brewis and White.

The first access to the property was by cat trains and small aircraft and by this means sufficient building material, mine equipment and operating supplies were moved to the property to commence shaft sinking in 1957, and lateral development in 1958. The Mathews Vein was found to contain gold in lenses and zones distributed irregularly throughout the vein and with quite a range of values. In this respect it was very different from the ore zones of Discovery where vertical continuity is very strong, and as a result, an accurate appraisal of the ore potential Tundra was difficult.

In 1958 a 4,000 foot air strip was constructed on a sand and gravel eskar about 3 miles from the property and this reduced transportation costs by utilization of the Bristol freighter aircraft.

Development work continued over a period of seven years, during which time the mine was investigated on 6 different levels to a depth of 1250 feet.

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Further reduction in transportation cost with the opening of traffic to the property by trailer trucks over winter roads had much to do with the decision to proceed with placing the property in production. Mill, powerhouse, and bunkhouse construction proceeded during 1962 and 1963 and as a result production was started in early 1964.

At Tundra Mine the perma frost extends downward for 900 feet, and it was feared that this might be a handicap to shrinkage stoping, with broken ore freezing while lying in the stopes. It now appears that enough heat is generated by the explosives and movement of ore to drive the frost into the walls and a problem that has been encountered is slabby ground on a weak hanging wall after the frost goes out. This is now being controlled by rock bolting and stull timbering.

Tundra has now been in operation for 2 years and is making a modest operating profit, its greater contribution to the annals of Canadian Mining, may however be, in demonstrating that mining operations may be carried out successfully in spite of the formidable obstacles encountered in the barren lands.

It has been demonstrated that these lands, in spite of their name, will support human life, this being demonstrated recently when the wife of one of the mill crew gave birth to the first child born at Tundra, and for students of sociology, it is interesting to record that the parents were both born in the middle east somewhere in Arabia!

Transportation

Perhaps the most formidable obstacle to overcome is developing mines in the north is the lack of transportation routes and the necessity of moving big tonnages of equipment and material over difficult terrain.

Originally in all the sweep of country from Alaska to Hudson Bay the only routes through these 1800 miles of Territory were down the Yukon and Mackenzie waterways. Away from these avenues of transportation exploration largely awaited improvements in the bush aircraft. In this regard the advent of the DeHavilland "Otter" was a great milestone for northern development.

This great workhorse of the aircraft industry still does a large percentage of the freighting to isolated points in the North. The Otter can land or take off in less than 2000 feet, can be equipped with pontoons, skis or wheels and will carry a payload of up to 2600 pounds at a cost of roughly $1.00 per ton mile.

For larger freight hauls and to points where improved landing strips can be provided, the Bristol freighter plane has in the recent years proved of great value. This aircraft requires a landing strip distance of 3500 feet and will carry a payload up to 12,500 pounds. The unique cargo doors allows loading of trucks, tractors etc. as well as long material. Freighting costs by Bristol will average about 35 cents per ton mile.

While the all year round service freighting north of Yellowknife is done mostly by small aircraft, up until recent years the cat trains played a large part in moving material beyond the reach of road or water transportation. Most of the equipment and building material for Discovery Mines camp was moved in by cat train, and until 1957 the year's requirement of building materials, mine, mill, warehouse and cookery supplies were still transported by cat train each winter. Cat train swings were usually made up of 3 or more units, each a D-6 or 7 or equivalent sized machine hauling 3 sleighs and the swing complete with diner and caboose. It was an impressive sight when the first swing of the winter arrived and you looked out and saw these monsters all snorting around on the ball field!

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Freight hauled by cat train could be landed for about 25 cents per ton mile, however since supplies were brought to Yellowknife by barge in the summer, warehousing and extra handling were costly items.

Completion of the Mackenzie Highway to Yellowknife has revolutionized freighting to that centre and to points north of there. All heavy freighting in to Discovery and Tundra Mines is now done by large trailer trucks. This phase of the operations is undertaken by a contractor who has the responsibility of building the winter road across the portages and chains of lakes and as it is 150 airline miles from Yellowknife to Tundra this is quite an undertaking. With normal cold weather, trucks usually start arriving shortly after Christmas.

With truck haulage, supplies are landed for about 15 cents per ton mile and this innovation has had a tremendous impact on these two Northern operations. When one considers that Discovery requires in excess of 600 tons of supplies each winter and that Tundra will require about the same plus 360,000 gallons of fuel oil, you will realise why these two operators try to maintain good relations with the cog grinders!

In the Yukon there is much less chance to use aircraft for freighting and so here, early access to mining properties is often provided by helicopter. This versatile machine carries a fairly small payload but supplies can be transported to nearly any kind of site for around $2.00 per ton mile.

There is no substitute for good dependable ground transportation in developing or operating a mining property. Here in the north assistance provided by the Tote Trail Assistance program is of utmost importance in developing this country and it is hoped that this program will be continued and expanded in the coming years.

Most of the country in the Yukon lends itself quite well to fairly reasonably priced road construction so that an expenditure of $2,000 per mile will generally yield a fairly serviceable bush road.

Camp Installations, Power, Communications

Anyone familiar with northern construction or diamond drill camps will be familiar with tent frame type of accommodation. This type of construction is still by far the cheapest and best suited to the needs of most exploration programs. A semi-insulated building of this type can be erected for from #3.00 to $5.00 per square foot of floor area or about $150 to $200 per man.

Where roads allow, trailer type accommodation will provide much more comfortable and permanent type of living quarters. Completely equipped trailers including washing facilities can provide housing for around $10.00 per square foot or $600 to $700 per man.

For a permanent camp, the frame type of bunkhouse accommodation is probably still the most suitable and economic. It can of course be constructed to suit the individual needs or type of ground of a particular camp. First rate bunkhouse accommodation can be provided for $12.00 to $15.00 per square foot occupied or $700 to $800 per man.

A rather interesting experiment we have tried at La Forma camp is to provide our bunk trailer wash car with a heavy duty automatic washing machine. This finds nearly constant use and has received many words of commendation from the crew.

Of prime importance to any development program is to maintain a good cookery set up. No single factor seems to do more to inspire good morale in a camp, or conversly to provide for unlimited grumbling than the state of the grub. A little extra money spent in serving good food, especially a selection of fresh fruit and vegetables is money well spent. Cost of board and lodging is quite a variable factor from place to place however a reasonable average is $1.50 to $2.00 per meal served.

Although the use of gas or oil lighting is usually sufficient for a surface prospecting program or initial diamond drilling work, once underground work commences or a large surface program, some form of power becomes necessary.

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There is a tendency to underestimate the future requirements, and also to overlook the need for standby equipment.

The small high speed air cooled diesel equipment is well suited for this type of requirement and can be operated for around 6 cents per kilowatt hour for fuel - any labour required extra. For larger blocks of power such as that required for milling, the bigger stationary diesel units using bunker "C" or similar type fuel if possible can be operated for around 3 cents per kilowatt hour.

Hydro power developed by Northern Canada Power Commission has played a good part in providing economies in operation for those mines located near a potential power source, or with the life expectancy to warrant such an installation. In Yellowknife area Giant, Con and Discovery Mines all purchase power from N.C.P.C. and although the generating facilities were doubled as recently as 1960, power is not as yet in over supply.

Personnel

The early phase of operations in these small isolated northern camps seems to attract the more rugged types of employees and to this type of individual the cold climate and privations of bush life have little effect. True, these camps also attract a higher percentage of the so called misfits of civilization particularly the chronic alcholics. However it is well to see how many of this type of personnel will find themselves, and lead a useful, healthy life in these surroundings when they can seldom hold down a job if confronted with the temptations of city life.

At the main Discovery mine for many years we have attempted to operate as a 'dry' camp, and since this is done without interfering unduly with the individual's freedom the system works quite well. It always rather surprised me in interviewing new employees how many, would volunteer the information that they approved of this policy and appreciated a chance to get a few dollars ahead.

To try and forestall the development of cabin fever, leave to return to town was granted fairly reasonably, and most of the camps have a policy of free round trip transportation back to town after 6 months of work. The Northern centre of Yellowknife could provide most of the amenities of city life and a lively miner could get into as much trouble there as anywhere!

The type of individuals who will adjust to isolated life best are those who have a hobby or who can utilize their off hours in improving themselves with some form of study. One chap comes to mind who had photography as a hobby and after a few years at Tundra accumulated a priceless collection of colour slides of arctic flowers and wild life; others have greatly enhanced themselves with courses of study from correspondence schools.

In a small camp the supervisor must at all times be ready to lend a sympathetic ear to the complaints and troubles of his crew. The welfare of these people is his direct responsibility and he must afford them succour when required.

One must also have a certain amount of tolerance in this type of work. I recall one time we had a mechanic overhauling and repairing the transmission from a 3 ton truck. He had it all apart and after several days finally got it all assembled and after a while came over to the office to announce that the job was finished but that he thought he had one cog wheel in backwards - did I want him to take it apart again or would the truck driver get used to 4 speeds backwards and 1 speed forward!

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In the mining future of the North we must not overlook the large native population already resident here. In these people, already acclimatized to northern living, we have one of our greatest resources. This huge pool of labour must be harnessed and put to useful work, but we must remember that they are barely two generations removed from the Stone Age, while we have had 4000 years in which to adjust to the conditions of the 20th century.

Native labour played a big part in the construction program at Rayrock Mines, and the speed in which that project was brought along was largely due to this ready supply of unskilled labour. At La Forma Mine, 5 to 10 percent of our crew have been recruited from the population of Carmacks, and we have been very well satisfied with the type of employee.

The present vocational training in the North is an excellent start and should at all costs be continued and expanded and supplemented if possible, with on the job training. The importance and advantages of good knowledge of speaking and writing English should be impressed on these trainees, and also, and equally important, an attempt to develop a feeling of responsibility to their employer and supervisors when they do go out on a job.

SUMMARY

In the history of Canada, the search for and production of metals has many times over attracted large numbers of people to new locations, and started the orderly settlement of these areas. We need only look across the map of Canada to places like Schefferville, Chibougamau, Noranda, Kirkland Lake, Timmins, Cobalt, Flin Flon, Barkerville, Rossland and closer to home, Dawson City, to realise what an impact the finding of minerals has had on the economy of these unpopulated locations.

From Alaska to Hudson Bay we have a great stretch of Territory upon which our imprint has been lightly made. No one who has set forth from Yellowknife by plane, and found out in the bush the modern confortable settlement of Discovery, or travelled 100 miles further north, well up into the Barren Lands and there seen the building of Tundra arising like an oasis in a vast desert of snow and ice, can fail to be impressed by what can be accomplished by the search for minerals.

These are but pin pricks on this vast map, but who can say that Tundra is not the start of another golden mill, such as Kirkland Lake, or likewise perhaps the encouraging developments on Vangorda Creek are but the beginning of another industrial complex such as Trail. Crest Iron is perhaps another Mesabi waiting to be developed.

This section of Canada, North of the 60° parallel is one of the last sizeable portions of our globe still relatively unsettled; and just a short distance from us, 800 million people are struggling for existance. The quest for minerals can lead to full utilization of this land, and serve as a foundation for future settlement. The partnership of Government and Industry is therefore urgently needed to proceed with the orderly development of this great stretch of land, and the quest for minerals is a good place to start. Let us proceed then with finding and developing more mines in the North.

C.H. Macdonald
Discovery Mines Limited
Carmacks, Y.T.

March, 1966

# MINERAL POTENTIAL OF YUKON

Presented to

YUKON NORTHERN RESOURCES CONFERENCE

Whitehorse, Yukon

By

L.H. GREEN

Geological Survey of Canada

Department of Mines and Technical Surveys

March 25, 1966

# MINERAL POTENTIAL OF YUKON [1]

by L. H. Green

In my talk, I propose to deal briefly with a number of metals and minerals of economic or potential economic importance in Yukon. By dealing with them in a general manner I hope to be able to present conclusions based on the deposits as we know them today and also to suggest other areas of possible interest. Mineral exploration still has a considerable element of chance in it and I think a good example of this is the Ross River-Vangorda area where the original Vangorda showing outcropped in a creek. Having walked much of this area in the course of regional geologic mapping, I would like to suggest that this area, that is now attracting so much attention, would still be written off as "moose pasture" were it not for this single outcrop.

Geological mapping of much of the Yukon has now been completed on a scale of one inch equals four miles and, in my opinion, the next phase of exploration will involve applying geochemical and geophysical techniques in conjunction with this geological information. Regional geochemistry, in particular, would appear to offer an efficient method of suggesting areas worthy of more detailed exploration. Work of this type has been done by a number of the larger exploration companies and, in the Keno Hill area, by the Geological Survey.

In discussing the subject of our mineral potential, the mineral production of the Yukon must be viewed in perspective with the rest of Canada. Since 1886 our mines, both placer and lode, have yielded metals and minerals with an estimated total value of about half a billion dollars. Our yearly production has remained relatively steady the last few years and, in 1965, is estimated at over 13 million dollars compared to over 279 million dollars for British Columbia and 3,737 million dollars for all of Canada. Part of this reflects the fact that, with a limited population our production of structural minerals, such as clay sand and gravel is negligible and that, with the exception of coal, our mineral products must be shipped to consumers elsewhere.

A simplified geological picture of the Yukon consists of a southern portion which has been intruded by granitic rocks and a northern portion of relatively unaltered sedimentary rocks with two small isolated areas of granitic rocks, one near Old Crow and the other Mount Fitton, near the Arctic coast. In the southern portion, two major structural lineaments, Tintina and Shakwak Trenches, slice northwesterly across the Yukon and have been traced far into Alaska. These features are believed to be major faults with suggested displacements of several hundred miles along them. To the north of Tintina Trench, older rocks, mainly Precambrian, and a thin belt of younger rocks have been intruded by scattered bodies of granitic rocks. Two small areas of metamorphic rocks, altered to granitic gneiss, occur in SE Yukon. In the block between Tintina and Shakwak Trenches, much of the rock is metamorphic rock, frequently referred to as the Yukon group, which has been much altered by granitic rocks, probably of more than one age. Within this belt a small area, mainly of Palaeozoic rocks with some granitic rocks, lies against Tintina Trench and a central Tagish Belt of much younger Mesozoic rocks cut by a few granitic bodies forms a central core. Southwest of Shakwak Trench, the geology is less certainly known, particularly in the more mountainous portions, but both Palaeozoic and Mesozoic rocks cut by scattered intrusive rocks are present.

Nearly all of the known mineral showings occur in southern Yukon where some granitic rocks are present. Relatively undisturbed sedimentary rocks, similar to those in northern Yukon, are barren throughout much of North America with the important exceptions of lead-zinc deposits, of the Mississippi Valley type, (including Pine Point, N.W.T.), and copper deposits of the Ruby Creek type in Alaska. To date, neither type has been reported from northern Yukon although they may be present.

1. Publication authorized by the Director, Geological Survey of Canada ... 2

GOLD

Gold has been the magic word connected with the Yukon since 17 August 1896, and total production, virtually all won by placer mining, is estimated at over 11 million ounces. From the start of the gold rush on, much time and energy has been spent attempting to find workable lode gold deposits within the placer areas but, to date, all have been unsuccessful.

In the Klondike region most of the bedrock consists of soft schists bearing lenses of quartz up to a few inches in size, cut here and there by rusty fault zones containing some quartz. Specimens of quartz carrying free gold have been found both in place and in placer concentrates but never in sufficient amounts to form a workable deposit. The concept that the Klondike placers formed through weathering of a vast amount of rock containing minute amounts of gold has been expressed almost from the beginning (McConnell, 1905, p. 61B).*1.

In the Mayo area, most of the larger valleys have been scoured by glaciation, in marked contrast to the Klondike region, and placer deposits probably lie much closer to their original source. In the Mayo area, the magic combination for a placer deposit appears to consist of country rocks, generally Precambrian, which have been intruded by granitic rocks and the two rock types subsequently eroded and the gold reconcentrated in an area free from glacial scouring. Dublin Gulch may be considered a "vest pocket" example of this relationship and its valley contains a number of gold-quartz occurrences which were explored unsuccessfully early in the century.

In the Dawson Range, a number of narrow, high-grade veins bearing gold or gold and silver values occur in both granitic and metamorphic rocks. Showings that have been mined or explored include the Laforma property (#17; Green, 1965, p.28)*2., the showings of Mount Nansen Mines Limited, including the Brown-McDade property (#18; Green, 1965, p.32). In most cases, showings are found where numerous late rhyolite and quartz porphyry dykes and sills have invaded the older rocks. A few marginal placer deposits are known in the area and there appears to be a close relationship between these and lode showings.

In the Wheaton-Carcross area of southern Yukon, gold- and silver-bearing quartz veins cutting both granitic and Mesozoic volcanic rocks have been explored intermittently since the turn of the century (Wheeler, 1961, p.119). The veins are generally narrow with erratic variations in precious metal content. Recently most of the showings have been restaked, some for the first time in many years, and one, the Big Thing (#51), is currently being developed underground, reportedly with encouraging results. In general, the district appears to offer promise for the development of small tonnage operations treating high-grade ore. It is doubtful if large tonnage operations can be undertaken unless a zone rich enough in quartz veins to be treated as a large low grade operation is discovered.

SILVER

Aside from silver associated with gold-silver deposits, most silver is won from deposits in which silver is the main metal of value and associated lead and zinc is of secondary importance. In general, deposits of the latter type consist of narrow veins bearing galena (lead sulphide) that contains fine grains of silver-bearing minerals, usually tetrahedrite. In deposits of this type a

*1 Names and/or dates refer to publications listed in the Selected Bibliography.

*2 #17 refers to property No.17 on the map "Mineral Showings and Properties, Yukon Territory" prepared for Yukon Resources Conference, March 1966.

lead concentrate bearing the silver must be shipped to a smelter for treatment and, with high transportation and mining costs, there can be little or no profit in shipping a lead concentrate without appreciable silver. A useful comparison in dealing with assays from this type of deposit is the ratio between the number of ounces of silver per ton and the percentage of lead. For example, a sample that assayed 40 ounces per ton of silver and 10 per cent lead would be referred to as having a 4 to 1 silver to lead ratio.

The main silver deposits occur in the Keno and Galena Hills area (Boyle, 1965) which has produced most of the 141 million ounces of silver, 464 million pounds of lead, 230 million pounds of zinc and 2½ million pounds of cadmium recorded from the Yukon. Most of the ore mined from the camp is won from veins in massive quartzite of probable Mesozoic age and has a 4 to 1 silver to lead ratio or better. The area is heavily covered with vegetation and slide rock and this, combined with deep permafrost, has made surface exploration extremely difficult. In the past, most showings were found by individuals hand shafting on their claims but in recent years the present operating company, United Keno Hill Mines Limited, has undertaken a major exploration program involving overburden drilling and geochemical sampling, which, together, have yielded much the same type of information obtained from shafting but at a rapid rate. Despite the fact that the area has been mined almost continuously since 1920 the camp still appears to have a good potential. From Keno Hill, similar Mesozoic quartzite has been traced in a sweeping arc to the Dawson area and, while some showings are known, the silver:lead ratios are generally 1-1.5:1, too low to excite great interest under present conditions. However, the entire belt would appear to warrant additional exploration.

Southwest of Tintina Trench, silver-bearing galena veins are being explored in the Sixtymile area (Green, 1966) and the Dawson Range (Casino Property #14; Green, 1965, p.34). Silver:lead ratios are in the order of 2:1 or less. The showings occur in either granitic or metamorphic rocks.

In the Boswell River area, east of Whitehorse, quartz veins with silver-bearing galena occur in metamorphic rocks. In general the veins are narrow and both the silver and lead content relatively low, however, the showings are scattered over a distance of about 5 miles (Green, 1966; Lees, 1936, p.23).

A distinctive type of deposit associated with massive limestone of Lower Cambrian age extends from the Ketza area, near Ross River, southeasterly into northern British Columbia. Generally, deposits of this group take the form of lenses parallel to the foliation of the limestone and enclosing schist although some cross-cutting veins are also present. Both silver assays and silver to lead ratios are erratic. Limited size, erratic assays, and high transportation costs have precluded mining these deposits in the past, even as high-grading operations. However, if smelter facilities were available in the general area it might be possible to mine a number of them as relatively small tonnage, high-grade operations. Examples include the Tintina Silver Property (#43; Green and Godwin, 1963, p.26) the Luck Group (#54; Green and Godwin, 1963, p.31) and the Frances River Syndicate property (#56; Green and Godwin, 1964, p.44).

LEAD-ZINC

Without precious metal values, lead-zinc deposits must be potentially large tonnage operations to be of economic interest. A number of such deposits occur in a varied geologic setting in southeastern Yukon and the area holds promise of becoming a major lead-zinc province.

In the Ross River area, the original Vangorda deposit (#21; Green and Godwin, 1964, p.31)was first staked in 1953 and the discovery of the Faro deposit (#20) in the same general area in 1965 sparked the mining boom currently underway in Yukon. Deposits in this area consist of large pyrrhotite and pyrite masses, in part containing potentially economic amounts of lead and zinc, that replace contorted schist and phyllite of presumed Mississippian age. The geological control of the deposits is unknown although a relationship to NE trending faults and to granitic rocks of the Anvil batholith has been suggested. Much of the area is deeply covered by glacial debris and geophysical and geochemical methods would appear to offer the most promising means of locating drill targets.

The Tom property (#13; Green, 1965, p.47), located near MacMillan Pass, is reported to contain over 10 million tons averaging about 5 per cent zinc. The deposit consists of a limestone band that has been replaced by barite and sphalerite (zinc sulphide) occuring in a sequence of black cherty slate and chert grain grit of Ordovician to Silurian age. Similar deposits may be expected in the same general area but the negligible lead content and relatively low zinc content mean that the deposit is of limited economic interest unless smelter facilities are available nearby.

The Norquest group of zinc showings (#38; Green, 1965, p.45), located just west of the Canada Tungsten road, occur in bands of marble within a sequence of metamorphic rocks that have been altered to schist and granitic gneiss. The marble bands are almost totally replaced by secondary silicate minerals and may contain up to 10 per cent zinc with some cadmium. The metamorphic rocks have been cut by granitic rocks and the showings range from marble bands, only partially altered and with minor zinc, to mere remnants of the altered bands that have not been engulfed by the granitic rocks. Zinc showings are widespread in this general area and it would appear to merit much additional prospecting. A few miles to the east, lead-zinc showings in skarn have been traced over a wide area (#32; Skinner, 1961, p.46). To the southwest of the Norquest group, a number of zinc showings were explored in the early 1950's. These showings are somewhat similar to the Norquest group in that they occur in carbonate bands, in part replaced by secondary silicates with some sphalerite, occuring in a sequence of quartzite and hornfels.

The MacMillan showing (#57; Green, 1966) is reported to contain about 1 million tons assaying 5 per cent lead, 10 per cent zinc and 1.8 ounces of silver per ton. The deposit occurs in a limestone bed occuring in a sequence of maroon and green shale and pebbly quartzite of Precambrian age. Rocks of this unit underlie much of the area immediately northeast of Tintina Trench but, aside from this showing and some in the Mayo district, the unit appears to be barren.

## COPPER

There has been limited copper production from Yukon in the past, mainly from mines in the Whitehorse Copper Belt and from Johobo Mine in the Haines Junction area. Chalcopyrite is the main copper mineral in most Yukon showings and the pure mineral contains little more than 1/3 copper. Thus, as mentioned by Dr. Smitheringale in his paper to the 1963 Resources Conference, it may not be economic to ship a chalcopyrite-bearing mill concentrate from more remote parts of the Yukon.

The deposits of the Whitehorse Copper Belt (#47) consist of contact metamorphic deposits with copper and iron minerals developed near the contact of Triassic limestone with granitic rocks. Past production is about 13 million

pounds of copper and the deposits are currently being prepared for mining; total reserves being estimated at about 5½ million tons containing 1.2 per cent copper. The three main deposits are spread over a distance of 15 miles and the ores will be trucked to a central mill located near MacRae. Similar copper showings are known elsewhere in the Whitehorse area and it would appear worthy of additional prospecting.

At the Johobo mine (#45; Green and Godwin, 1963, p.24) in the Haines Junction area, over 1 million pounds of copper have been produced from massive lenses of copper-bearing minerals in Mesozoic volcanic rocks. Copper minerals include chalcopyrite and bornite, the latter mineral containing over 60 per cent copper. The massive nature of the copper minerals and the presence of much bornite enabled operators to hand sort material containing over 20 per cent copper. Known lenses on the property have been mined out.

Native copper float, with other copper minerals including chalcocite (about 80 per cent copper), have been known in the White River area since before the turn of the century (#26; Cairnes, 1915) and the big slab of native copper in front of McBride Museum in Whitehorse comes from this area. I think it should be pointed out that native copper of this type is known in association with volcanic rocks in many places throughout the world but the only important camp is in the Lake Superior district.

The Kennecott copper deposit, now worked out, is located in Alaska about 75 miles southwest of the White River area. This deposit contained copper-rich minerals, mainly chalcocite, deposited near the contact between limestone and underlying volcanic rocks, both of Triassic age. Total production of the camp is estimated at 1.2 billion pounds of copper all from mines on a single mountain. Projecting regional geological trends similar relationships may occur in the area of mountains and glaciers in southwestern Yukon. Considerable exploration has been carried out both in Alaska and Yukon but, to date, the Kennecott deposit remains unique.

Scattered copper deposits have been explored in the metamorphic rocks between Shakwak and Tintina Trenches. These include contact metamorphic deposits in the Aishihik Lake area and a deposit associated with a small quartz porphyry intrusion near Big Creek. In general, this belt lacks the combination of Mesozoic volcanic rocks cut by young intrusive rocks that appears to offer so much potential for large-scale copper deposits in the Stikine area of northern British Columbia.

Two copper deposits, Fire Lake (#40) and North Lakes (#39), occur in granitic gneisses on the northeast side of Tintina Trench in the Pelly Plateau area. Both are reported (Skinner, 1962, pp.39-41) to consist of bands of schist that have been replaced by iron and copper-bearing minerals, mainly chalcopyrite. Deposits of this type are of limited economic interest because of transportation costs and the relatively low copper content of a concentrate made from chalcopyrite. However, if quantities of cheap sulphuric acid were available in the area it might be possible to treat the ore by leaching to produce a higher grade product.

North of the Mayo area, a number of small chalcopyrite-rich showings occur in relatively unaltered Precambrian carbonate rocks. These showings are in the form of narrow veins often with patches of relatively pure chalcopyrite. The known deposits appear small and of limited economic interest.

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MOLYBDENUM

Only a few molybdenum showings are known in Yukon and none are known to be of the disseminated replacement type from which the bulk of world production is drawn.

In the extreme southwest corner of Yukon, molybdenite float has been reported from Steele Glacier (Bostock, 1950, p.9) and to the northeast across Tintina Trench a number of small showings have been explored.

In the Pelly Mountains area, exploration work was done on two molybdenite showings (#37; Skinner, 1961, p.41) and (#42; Green and Godwin, 1963, p.45) of the contact metamorphic type. Both proved of limited size although of reasonably good grade.

ASBESTOS

Ultrabasic rocks, the host for asbestos deposits, occur scattered through a broad belt immediately southwest of Tintina Trench and a smaller one northeast of Tintina Trench in southern Yukon. The only deposit being developed at present is the Clinton Creek property (#4, Green, 1965, p.25), but asbestos fibre is known from many other ultrabasic bodies. The latter show well in aeromagnetic mapping and, when additional maps of this type are published in the next few years, it seems reasonable to expect that a number of previously unknown ultrabasic bodies will be revealed for additional exploration.

IRON

Hematite (iron ore) float has been known in the Yukon since early in the century but the Snake River deposit was not discovered until late in the 1961 field season, and was staked early in 1962. The iron formation occurs in rocks of late Precambrian age which were deposited in an arc along the present Mackenzie Mountains and into what is now northern Yukon. However, much of the iron formation was folded and eroded before the overlying rocks were laid down and only isolated pockets remain. The best deposit is at Snake River (#2; Green, 1965, p.22) where one proposed open pit alone contains over one billion tons. The iron formation contains between 40 and 50 per cent iron and some form of concentration would be required to produce a commercial product.

A body of specular or micaceous hematite (#3) occurs at the contact of two Precambrian formations in the same general area and another magnetite deposit has been investigated northwest of Dawson. In both cases, the material could readily be upgraded to a high iron content with relatively simple treatment but, in both, tonnages are as yet unknown and the problem of developing a low cost transportation system to tidewater remains.

COAL AND LIGNITE

Coal and lignite have been mined in a number of locations and are known in others. Much of the mining took place in conjunction with the development of the Klondike placers and the deposits mined are either close to Dawson or along the Yukon River, the main transportation route of the period.

Coal measures of Jura-Cretaceous age are known in a number of places in the Tagish Belt but have only been worked in the vicinity of Carmacks. Except at

the Tantalus Butte Mine (#17), currently being worked, and the former Tantalus Mine, across the river, little is known of the thickness or quality of coal seams. Small areas of coal have been described (Wheeler, 1961) in the Whitehorse area but these appear of limited potential.

Tertiary lignite occurs along Tintina Trench and attempts to mine these in the Dawson area met with indifferent results. Float can be observed along many of the streams crossing Tintina Trench but the few exposures observed suggest that seams are thin and that complex folding is present. There seems little prospect of these deposits becoming economic.

Subbituminous coal of Tertiary age occurs in the Kluane area southwest of Shakwak Trench (Muller, 1958, p.9) and one section of about 18 feet contained 10 feet of clean coal.

Tertiary lignite was reported in the Bonnet Plume Basin by Camsell (1906, p.47CC) with the largest seam 30 feet in thickness and another 8 feet.

## NICKEL

Two nickel deposits occur in Palaeozoic rocks a few miles southwest of Shakwak Trench. Both occur near a thin serpentine sill and consist of nickeliferous pyrrhotite in altered sedimentary and volcanic rocks. At the Wellgreen deposit (#27), on Quill Creek, the developed tonnage is reported to be 737,000 averaging 2 per cent nickel and 1.42 per cent copper plus cobalt, gold and platinum, and at the Canalask property (#25), on White River, the tonnage is reported as 542,000 tons averaging 1.68 per cent nickel. The belt between the two showings would appear favorable for other nickel deposits and worthy of detailed exploration.

One small nickel showing was explored in the Ross River area in 1963 (#30; Green and Godwin, 1964, p.42) but little was found in place and the assays obtained were below commercial grade.

## TUNGSTEN

There are no commercial tungsten deposits in Yukon but the Canada Tungsten property (#24) is located a few miles east of the Yukon boundary and the operation makes a substantial contribution to the economy of the Yukon. The deposit occurs in metamorphic rocks developed near the contact of a distinctive Lower Cambrian "ore limestone" with granitic rocks. Much of the "ore limestone" was removed by erosion prior to the deposition of the overlying rocks and areas where remnants remain and are in contact with granitic rocks are the most promising for exploration. Some showings are also present at the contact of younger limestones with granitic rocks but most appear unlikely to be of commercial value (Green and Godwin, 1963, p.34).

About 110 miles to the northwest, along the Northwest Territories-Yukon boundary, a tungsten deposit, occuring near the contact of granitic rocks with limestone of Late Cambrian or Ordovician age, has been explored (#12; Green, 1965, p.48). No estimate of tonnage is possible without diamond drilling.

Other minor deposits include a quartz vein carrying the tungsten mineral wolframite (#55) near the Alaska Highway in southeastern Yukon and areas where tungsten-bearing minerals occur in placer concentrates, particularly Dublin Gulch and Canadian Creek (all described in Little, 1959, pp.14-37).

ANTIMONY

Antimony showings are known in the Wheaton River area, near Whitehorse, and one deposit, the Becker-Cochran (#50), is currently being explored underground. The deposit is in the form of a quartz vein, carrying the antimony mineral, stibnite, and cutting altered felsic volcanic rocks. Other showings in the same area are similar and, in some cases, carry precious metal values.

Stibnite-bearing quartz veins occur in the Highet Creek area northwest of Mayo (Green, 1966), and a stibnite showing is known in the Fish Creek area northeast of Dawson.

SUMMARY

Briefly my ideas of the mineral potential of Yukon may be summarized as follows:

Gold: Considerable potential for small gold and gold-silver operations, particularly in the Dawson Range and Carmacks area. No mineable deposit that could have been a source for the Klondike placer deposits is known.

Silver: Continued production can be expected from the Keno and Galena Hills areas. Lower grade deposits elsewhere in Yukon may come into production, particularly if smelter facilities are available.

Lead-Zinc: A major lead-zinc province appears to be present in southeastern Yukon with the best deposits in the Ross River area.

Copper: Potential production from the Whitehorse Copper Belt. Elsewhere, deposits discovered to date do not appear to hold much potential for large tonnage operations.

Molybdenum: Some showings are known but these do not appear to hold much potential for large tonnage operations.

Asbestos: Ultrabasic rocks, the host rock for asbestos are widespread, and many undoubtedly remain to be explored.

Iron: Large tonnages of low grade material are present.

Coal: Considerable reserves of good quality coal may be present in the Tagish Belt. Exploration to date has been concentrated near Dawson and along the Yukon River.

Nickel: A nickel belt worthy of exploration appears to be present on the southwest side of Shakwak Trench.

Tungsten: Considerable potential for tungsten deposits may exist along the Northwest Territories-Yukon boundary region, particularly near Tungsten, NWT.

Antimony: Some potential for relatively small-tonnage operations.

Basically, the brightest future appears to lie with large tonnage, highly mechanized, operations while small tonnage operations, requiring a large labour force, may be faced with ever increasing costs per ton mined.

Once again, I must stress that this talk is based on mineral showings as they are known today. Outcrop is poor in much of our Territory and I cannot help feeling that careful prospecting by conventional, geophysical and geochemical means will prove the above unduly pessimistic within the next few years.

REFERENCES

Bostock, H.S.

1950: Potential Mineral Resources of Yukon Territory, 1950; Geol. Surv. Can., Paper 50-14

BOYLE, R.W.

1965: Geology, geochemistry, and origin on the lead-zinc-silver deposits of the Keno Hill-Galena Hill area, Yukon Territory; Geol. Surv. Can., Bull.111.

CAIRNES, D.D.

1915: Upper White River District, Yukon; Geol.Surv.Can., Memoir 50.

CAMSELL, C.

1906: Report on the Peel River and Tributaries Yukon and Mackenzie; Geol. Surv. Can., Ann. Rept., Vol XVI pp.7 CC - 49 CC.

GREEN, L.H.

1965: Mineral industry of Yukon Territory and southwestern District of Mackenzie, 1964; Geol.Surv.Can., Paper 65-19.

1966: Mineral industry of Yukon Territory and southwestern District of Mackenzie, 1965; in preparation.

GREEN, L.H., and GODWIN, C.I.

1963: Mineral industry of Yukon Territory and southwestern District of Mackenzie, 1962; Geol. Surv. Can., Paper 63-38.

1964: Mineral industry of Yukon Territory and southwestern District of Mackenzie, 1963; Geol. Surv. Can., Paper 64-36.

LITTLE, H.W.

1959: Tungsten deposits of Canada; Geol.Surv.Can.,Econ.Geol.Series No.17.

McCONNELL, R.G.

1905: Report on the Klondike Gold Fields, Yukon; Geol.Surv.Can., Ann. Rept., Vol. XIV, pp. 5B - 71B.

MULLER, J.E.

1958: Kluane Lake map-area, Yukon Territory; Geol.Surv.Can., Paper 58-9.

SKINNER, R.

1961: Mineral industry of Yukon Territory and southwestern District of Mackenzie, 1960; Geol.Surv.Can., Paper 61-23.

1962: Mineral industry of Yukon Territory and southwestern District of Mackenzie, 1961; Geol.Surv.Can., Paper 62-27.

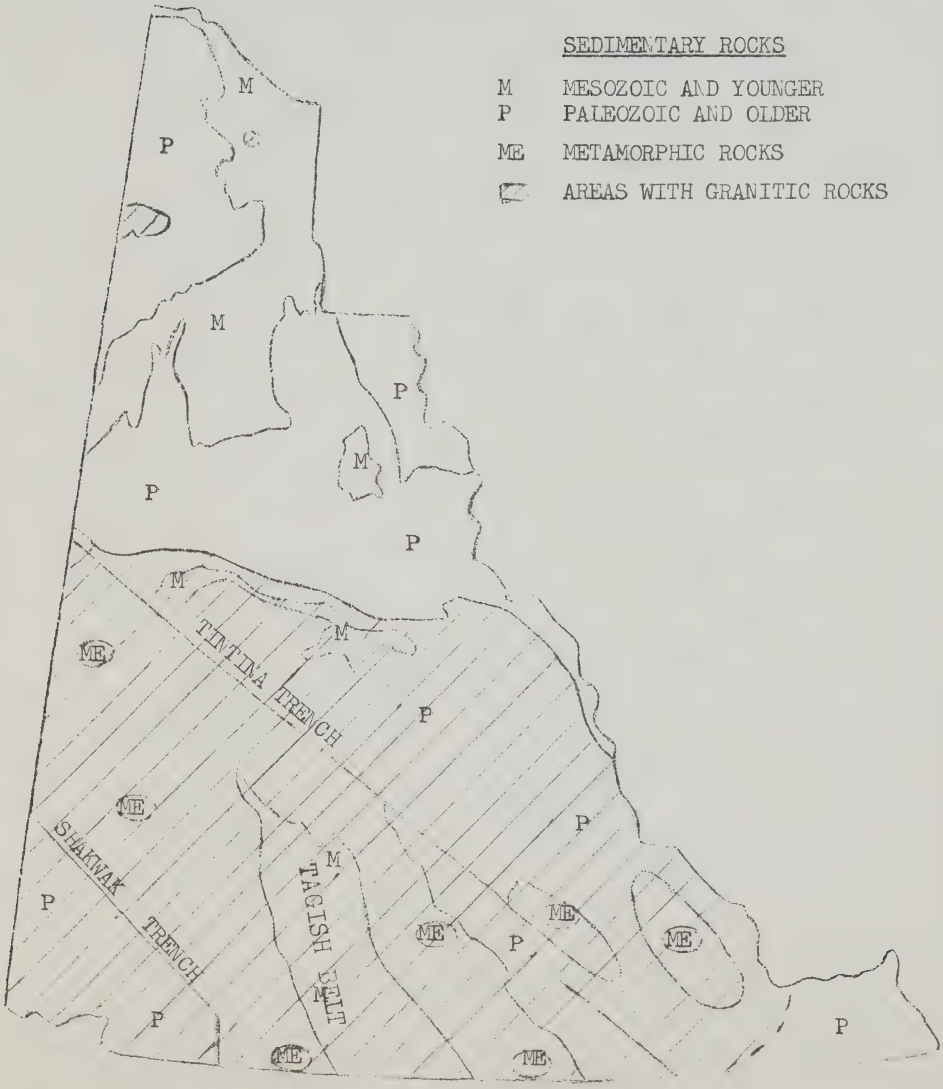
WHEELER, J.O.

1961: Whitehorse map-area, Yukon Territory; GeolSurv.Can., Memoir 312.

LEES, E.J.

1936: Geology of Teslin-Quiet Lake area, Yukon Territory; Geol.Surv.Can., Memoir 203.

# STRUCTURAL ELEMENTS OF YUKON



THERMAL POWER GENERATION

# THERMAL POWER GENERATION

A PAPER PREPARED FOR PRESENTATION

AT THE

SECOND NORTHERN RESOURCE CONFERENCE

WHITEHORSE, YUKON TERRITORY

MARCH 24, 1966

By

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Canadian Utilities, Limited

March 1966

## INTRODUCTION

I would first like to express appreciation on behalf of Canadian Utilities, Limited for being asked to present this paper. It is a personal pleasure to be present and to have this opportunity to visit the Yukon.

You will note I have taken the liberty of shortening the title for this paper from that published on the printed program. It seems fitting to review the topic of thermal power on a more general basis and to attempt to relate it to the specific needs of the Yukon.

## DEFINITION OF THERMAL PLANT

A thermal plant is defined as "a generating plant which uses heat to produce electricity. Such plants may burn coal, gas, oil, or use nuclear energy to produce the necessary thermal energy".(1)*

This definition is broad in its scope and as such includes diesel engines among other prime movers. Many of these, although limited in size, are already in service in the Yukon.

Of the estimated total power generating capability in Canada as of December 31, 1965, 24.5% was thermal plant type(2) and of this 91.5% was conventional steam-electric generation. In the United States in 1964 conventional steam-electric generation was the source of four out of five kilowatt hours of electric energy produced.(1)

It is for this reason that the term thermal plant usually refers to a conventional steam-electric generating plant. This discussion will be limited to this kind of thermal plant.

## ELECTRICAL INDUSTRY

Electric energy is becoming so basic to our lives that we take it for granted. In industrially developed countries electric power ranks among the largest industries in the economy, no matter what measure of size is used.(1)

* Numbers in parenthesis refer to references in bibliography

Power systems evolve. They usually start out with a small plant serving a small local load. The next phase is that by small amounts of transmission additional load is served by adding increments to the plant. Eventually as load develops, two adjacent systems will touch and interconnect. At this point the two individual plants will be in competition on an incremental production basis. Economic pressure or technological change will cause the least expensive plant to be developed or both plants to be replaced by an alternate more economic supply from possibly a large central station located at a distance. Because of the increase in load it is possible to take advantage of economies of size and better utilization of equipment. The Yukon has the advantage that the technology required for development for some time to come has already been developed by the electrical industry.

Once the load requirement conditions present themselves, known technology can be applied. This situation will permit tremendously rapid development.

Two features of the industry's technology characterize the development of economical power supply: SIZE and UTILIZATION. These two characteristics will be considered in turn as related to thermal power generation. For purposes of comparison estimated costs are used for a thermal plant burning coal and with a range of sizes suitable for a Yukon development.

## SIZE EFFECT IN THERMAL PLANTS

There are two aspects of size effect. The first relates to the capital investment required and the second relates to efficiency of production.

Table 1 lists the estimated capital costs to construct three different sizes of coal fired thermal generating plants. The average cost per KW is plotted against plant size on Figure I and shows the marked effect upon unit investment as the plant and unit size becomes larger. There is approximately 47% decrease in unit capital investment when increasing from 6,000 KW units to 30,000 KW units. This size effect continues as the unit size increases further although at a decreasing rate.

Two principal operating costs affected by unit and plant size are labour and thermal efficiency. These are also shown on Table I. Plant staff

per MW for the 90,000 KW plant reduces to one third and the heat rate to 86% of the 18,000 KW plant.

Thus in conventional steam plant development every effort is made to use unit sizes as large as possible in keeping with the size and nature of the load to be served.

## UTILIZATION OF THERMAL PLANTS

Utilization of thermal plants depends on the nature and character of the load served. A measure of utilization is Capacity Factor, being by definition "the ratio of average load on a machine or equipment for the period of time considered to the capacity rating of the machine or equipment". (3) A measure of character of load similarly is called Load Factor and is the ratio of average load during a designated period to the peak or maximum load occurring in that period. (3)

The load factor on a plant is given by the load itself. It does not depend upon the kind of plant or number of units except possibly in the case of an interruptible supply.

The capacity factor of a plant as a whole can never be better than the load factor and in fact is usually lower for several reasons. First, plant installations are normally kept on the large size to provide for load growth. It is also difficult to predict the load and to match the generating equipment size exactly to it. Second, all equipment requires down time for scheduled and unscheduled maintenance. If the nature of the load is such that interruptions for maintenance are undesirable the alternative is to install additional capacity. In an isolated system this additional capacity is equal to the size of the largest generating unit. When a particular load has a peak of a relatively few hours in a year this margin of reserve capacity may be reduced slightly by relying on the probability that forced outages of equipment will not occur during periods of peak load.

The load factor of electric loads can vary over a wide range, from as low as 26% for an isolated community such as Old Crow where most of the load is lighting, to theoretically as high as 90% for a base load type of industry such as envisaged for a mining project. For comparison the interconnected system load factor within the Province of Alberta for 1965 was approximately 53%.

FIXED CHARGES

"Electric power costs are usually estimated in terms of their fixed and variable components. Fixed costs consist of annual fixed charges and other cost components which are essentially unaffected by output, i.e. the number of kilowatt hours generated. Fixed charges are generally considered to include cost of money, depreciation (or amortization), interim replacements, insurance and property taxes. The variable costs are principally those associated with the amount of generation such as fuel, payroll, labour and other operating and maintenance expenses".(1)

Fixed charges on capital investment can be calculated for a plant in the Yukon in a manner similar to that used by the Federal Power Commission in the U.S. National Power Survey.(1) Including the items listed above and assuming a 25 year life, the average fixed charge rate for a conventional steam plant in the Yukon at the present time would be somewhere between 14% and 15%.

THERMAL PLANT LOCATION

The economic considerations affecting the siting of a thermal power plant are fuel supply, water supply, load, site suitability and other considerations such as pollution.(4) The most important is the combination of fuel and water.

The type of fuel can affect the plant location. In 1957 D. Cass-Beggs concluded "Where coal must be moved a considerable distance to a plant, it will almost always be more economical to place the generating plant close to the mine and transmit the power". On the other hand "Where gas is available as a fuel it will almost always be preferable to locate the plant at the load centre and transmit the gas".(5)

WATER SUPPLY

The need for fuel, load and site is obvious. An abundant water supply is needed for condenser cooling. Water is also used in the boiler feedwater system, but being a closed loop, purity of supply is more important than quantity. A simplified schematic diagram of a modern steam plant is shown on Figure II.

The starting point in the feedwater cycle is the boiler feed pump. This

pump supplies condensate to the boiler where it is converted to steam. This steam leaves the boiler in varying degrees of superheat and passes through the steam turbine imparting energy to the turbine. The steam turbine in turn drives the generator which produces power. Once through the turbine, the steam passes through a condenser and returns to the feed water pump. Make-up water is added to counteract the losses caused by leakage and blowdown. The make-up water is natural water treated to remove dissolved salts and gases. organic and inorganic material in suspension.

Natural water is used for cooling the turbine and generator and condensing the steam as it leaves the turbine. In some cases the generator is cooled, using hydrogen as a cooling medium.

Steam turbine generating units are more or less custom constructed. Both the turbine generator and steam generator manufacturers are geared to handle standard sizes and they modify from these standards to meet specific customer requirements.

FUEL SUPPLY

Principal fuels used in conventional steam plants are coal, oil and natural gas. The simplest to handle and use is natural gas followed closely by fuel oil.

Coal requires elaborate handling and burning systems.

Methods of handling coal are an important aspect of power station design, and the coal handling equipment is one of the major components of station cost. Upon delivery to the station, coal is unloaded either to "live" storage or "dead" storage. The term "live" describes storage from which coal may be withdrawn to supply combustion equipment with little or no handling. "Dead" storage is that holding area from which coal can only be taken by the exercise of a definite reclaiming activity and conveying activity. Dead storage is ordinarily an exposed pile, laid directly on the ground.

When coal is piled in storage it "weathers". It has a tendency to become slack; to oxidize with the accompanying liberation of heat. Spontaneous combustion is aggravated by deep piling and exposure to winds. The best known

remedy is to exclude air from the pile by rolling and packing an air-tight layer of fine coal on the surface.

The proximity to the source of coal, the ease of conveyance of the coal to the station and whether the station operates as a base load or peaking station, all have a bearing on the size of coal storage.

Equipment to handle coal at a station is custom selected for specific needs. A handling system commonly used in Western Canada consists of an unloading hopper which receives the coal from trucks or similar coal haulers and discharges it to a conveyor system. The conveyor system feeds a crusher from which the coal is delivered to either live or dead storage.

Once the coal is in the live storage bunker, the type of coal and size of station determines further treatment. In power station use for the size under consideration the pulverized and stoker burners are the most prevalent. For a pulverized coal burner, the coal goes through a mill which reduces it to flour-like fineness. Primary air is admitted to the mill and becomes the transport air which carries the coal through the delivery pipe to the burner. Coal is pulverized to increase its surface exposure, thus promoting rapid combustion.

Spreader stokers are popular and widely used for smaller sized boilers. The principle of spreader stoking is the sprinkling of coal, evenly and thinly, over a moving grate which forms the bottom of the furnace. Air for combustion is admitted from below the grate. Only the lumps reach the grates as the finer particles burn in suspension.

One of the products of combustion that must be contended with is ash. There are two types of ash; one collects in the ash pit at the base of the furnace, the other, flyash, is suspended in the gas stream and is collected before entering the stack. The flyash has a commercial use as an ingredient in concrete and can be sold if there is a market. Ash disposal as a problem can assume large porportions in larger thermal plants.

## COAL AT CARMACKS (6)

Published literature shows several areas in the Yukon Territory where coal has been discovered, usually along travelled routes.

The best known and most important area is that in and around

Carmacks, Y.T. The first mine of record was operated by the Five Fingers Coal Co., organized in 1905.

In recent years it is believed the entire reported production of coal for the Yukon has come from the Tantalus Butte Mine at Carmacks, Y.T.

Canadian Utilities, Limited has recently had the feasibility of supplying fuel for a thermal plant in the Carmacks area studied by S. P. Lang, P. Eng., Research and Development Engineer of Alberta Coal Ltd., Calgary, Alberta. Some conclusions of this work are:

1. The Tantalus Butte Mine, as now developed, has proven reserves of about 500,000 tons including support pillars protecting the main gangway.

2. An exploratory program is necessary to prove up additional reserves to include underground drilling, surface trenching and possibly drilling and the driving of the main gangway underground to the exclusion of other development work other than driving of occasional raises to the surface for ventilation.

3. Development work done since the mine was reopened in 1948 has been only enough to supply 8,000 to 9,000 tons per year and proved reserves for the foreseeable future at that tonnage. However one important result of this work has been to show a substantial and persistent coal seam (12' thick at face) which can be expected to give the strike length required (2.2 miles) for a possible reserve of 3,125,000 tons.

4. The possibility exists that other coal seams will be found as reported by several authors including D. D. Cairnes, H. S. Bostock and W. J. Dick. Exploratory drilling underground will prove or disprove this. Should other seams of mineable width and quality be discovered, the situation as to reserves will be enhanced thereby.

5. According to analyses made by the Fuels and Mining Practise Division, Department of Mines and Technical Surveys, Ottawa, as recently as October 1965 (Divisional Report FMP 65/152 Prep) a heating value of 11,800 BTU per pound of coal as received can be used.

COAL AT CARMACKS (cont'd)

6. Coal from this mine will cost about 37¢ per million BTU's as fuel for a mine-mouth thermal plant.

COAL RESERVES

The amount of coal reserves required for a thermal plant will depend upon the size of plant, expected life and load factor. Assuming a 90% load factor, a load of 30,000 KW, and possible coal reserves of 3,125,000 tons, there would be sufficient coal to last over 20 years.

PLANT STAFF

An important aspect of a thermal plant is staff. A number of highly qualified personnel are required to operate and maintain a conventional steam plant. A typical list would include:

| | |
|---|---|
| 1 | - Station Chief (1st Class Steam Engineer) |
| 1 | - Assistant Station Chief (1st Class Steam Engineer) |
| 4 | - Shift Supervising Engineers (2nd Class Steam Engineers) |
| 4 | - Operating Engineers (2nd & 3rd Class Steam Engineers) |
| 4 | - Firemen |
| 4 | - Apprentice Firemen |
| 1 | - Station Electrician |
| 1 | - Electrician Helper |
| 1 | - Station Maintenance Foreman |
| 1 | - Welder |
| 1 | - Lab Technician |
| 1 | - Senior Clerk |
| 1 | - Junior Clerk |
| TOTAL 25 | |

In addition it is likely that two or three temporary labourers would be required. Steam engineers are required to possess specified operating experience as well as pass written examinations in order to progress to the next higher level. The requirements for the various levels come under the jurisdiction of the Boiler Acts which vary from Province to Province.

Since accommodation is rather limited at Carmacks it is likely that a housing development would have to be instigated. The addition of the thermal station staff and their families would contribute substantially to a community the size of Carmacks.

## COSTS

The costs associated with different sizes of thermal plant located at Carmacks are estimated as shown on Table II.

Figures III, IV and V show graphically the effect of the various parameters discussed on the bus bar costs in Mills per KWH. It is apparent that for the sizes of plant considered there is approximately 20% reduction in bus bar costs in foregoing the reserve margin required for firm power. By increasing the load factor from 50% to 90% the bus bar cost is reduced between 35% and 50%. These two factors alone could account for between 61% and 82% difference in bus bar costs for the plants considered.

## COMPARISON WITH HYDRO

It is not possible to make a direct comparision here of costs for equivalent sized hydro plants because of the lack of information.

Steam plants are generally characterized by relatively low capital costs and relatively high operating and maintenance costs when contrasted with hydro plants which are characterized by relatively high capital costs and relatively low operating and maintenance costs.

The effect of a high load factor is to increase the relative significance of fuel costs in the total cost. Therefore reducing the load factor would be in favour of the thermal plant.

No consideration has been given to the cost of transmission on the cost of delivered power. Transmission costs would have to be added to generation costs for a particular project.

Each case must be carefully analysed using available information should it be necessary to decide between hydro and thermal generation.

## CONCLUSIONS

1. Size and Utilization have marked effects upon power costs.
2. Given a suitable load electric power could be produced in a thermal plant at Carmacks, Y.T. at realistic costs.

BIBLIOGRAPHY

1. National Power Survey, Federal Power Commission 1964, Washington: U.S. Government Printing Office, October 1964.

2. Canadian General Electric Brochure, "Electric Power and Prosperity in 1965..... and Beyond". (3172J-1-65 GP).

3. Glossary of Electric Utility Terms, Financial and Technical, 1961. E.E.I. Publication No. 61-31. New York: Edison Electric Institute, 1961.

4. Problems in the Design and Operation of Thermal Power Stations. Volume 1, United Nations Publication ST/ECE/EP/23. New York: 1964.

5. Cass-Beggs, D, "Assessment of Costs for Power Generation and Transportation". Proceedings, Ninth Annual Dominion - Provincial Coal Research Conference, August 30 - September 1, 1957, pp. 99 - 117. Reproduced as Mimeographed Circular No. 24 Research Council of Alberta, Edmonton, Alberta.

6. Lang, S.P., Private Communications with Canadian Utilities, Limited, February 1966.

TABLE 1

COAL FIRED STEAM PLANT DATA

| Plant Capacity | Installed Units | Capital Investment | | Plant Staff | | Plant Efficiency |
|---|---|---|---|---|---|---|
| (KW) | KW | $/KW | Total | Persons/MW | Total | BTU/KWH |
| 12,000 | 2 x 6,000 | 319 | 3,823,000 | | | |
| 18,000 | 3 x 6,000 | 310 | 5,588,000 | 1.0 | 18 | 16,000 |
| 30,000 | 2 x 15,000 | 216 | 6,479,000 | | | |
| 45,000 | 3 x 15,000 | 203 | 9,141,000 | 0.58 | 26 | 15,700 |
| 60,000 | 2 x 30,000 | 173 | 10,335,000 | | | |
| 90,000 | 3 x 30,000 | 163 | 14,614,000 | 0.33 | 30 | 13,800 |

TABLE 2

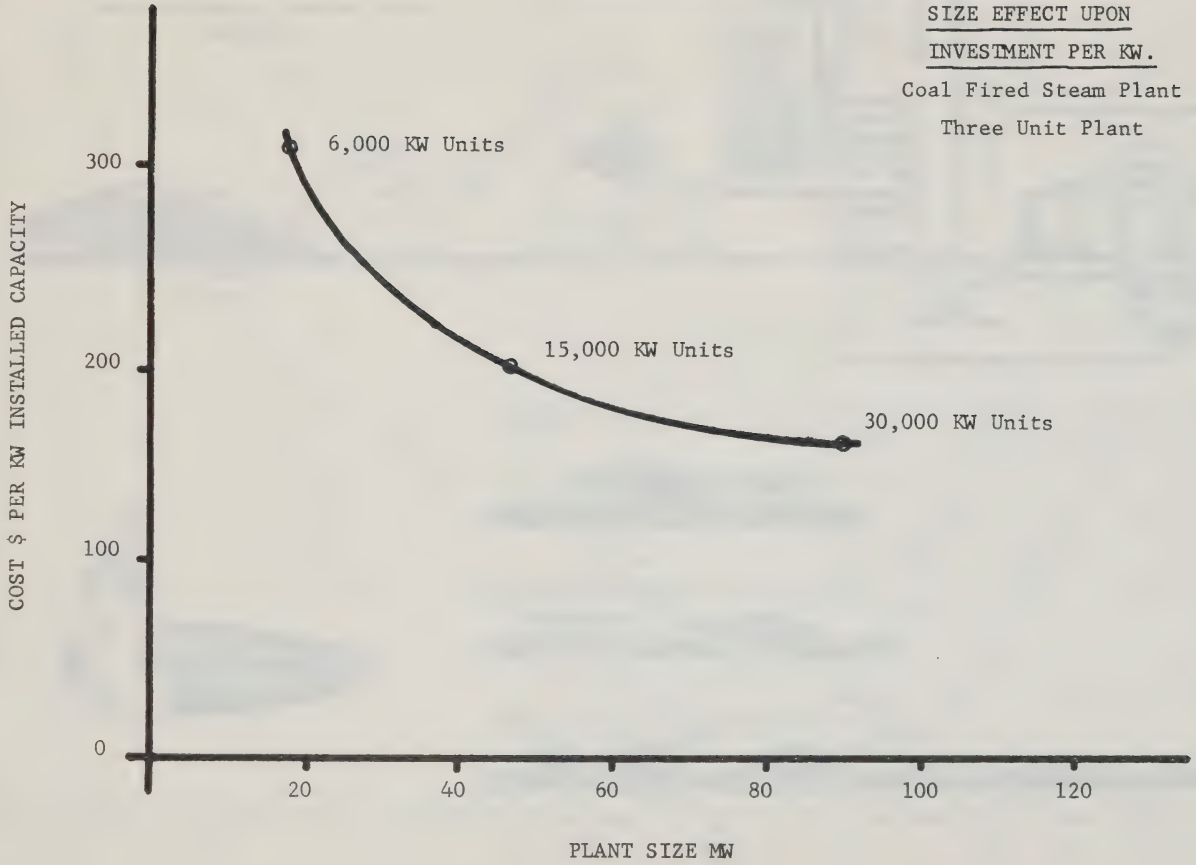
COAL FIRED STEAM PLANT

PRODUCTION COST - BUS BAR

| Load | Load Factor | KWH Produced | Fuel | Other O & M | Fixed Charges | | Total | |
|---|---|---|---|---|---|---|---|---|
| (KW) | % | (KWH x $10^6$) | Mills/KWH | Mills/KWH | 0% Margin | 50% Margin | 0% Margin | 50% Margin |
| | | | | | | | Mills/KWH | |
| 12,000 | 50 | 52.6 | 5.9 | 4.0 | 10.6 | 15.4 | 20.5 | 25.3 |
| | 90 | 94.6 | 5.9 | 2.2 | 5.9 | 8.6 | 14.0 | 16.7 |
| 30,000 | 50 | 131.4 | 5.8 | 2.4 | 7.1 | 10.1 | 15.3 | 18.3 |
| | 90 | 236.5 | 5.8 | 1.4 | 4.0 | 5.6 | 11.2 | 12.8 |
| 60,000 | 50 | 262.8 | 5.1 | 1.6 | 5.7 | 8.1 | 12.4 | 14.8 |
| | 90 | 473.0 | 5.1 | 0.9 | 3.2 | 4.5 | 9.2 | 10.5 |

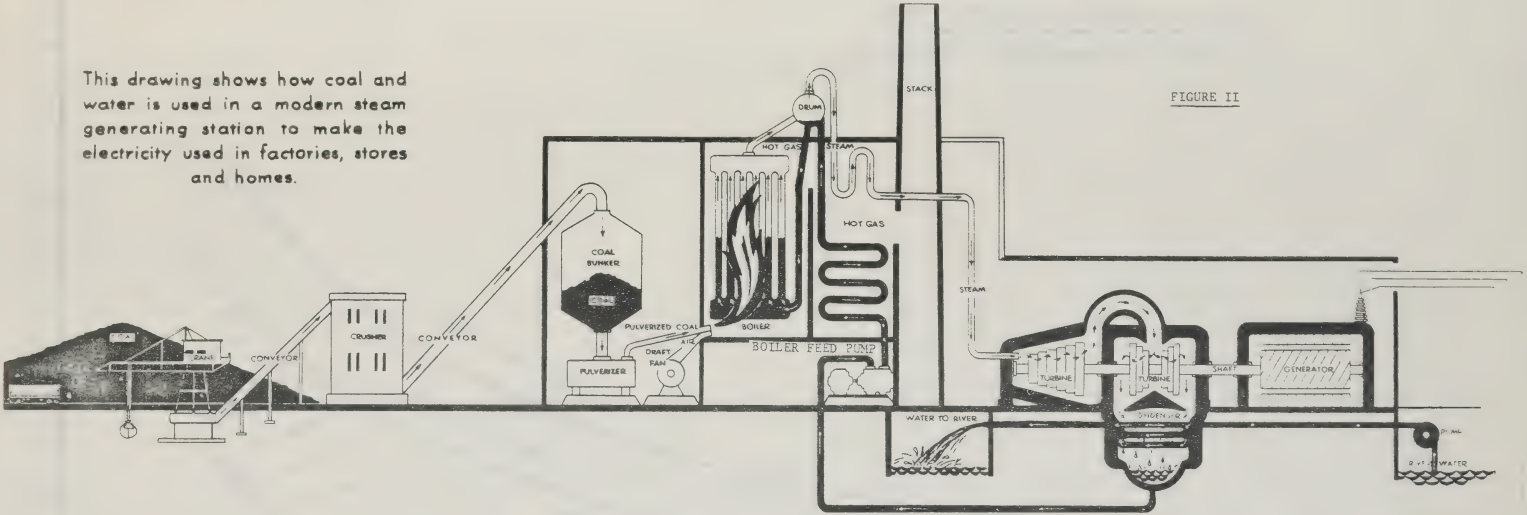
FIGURE I

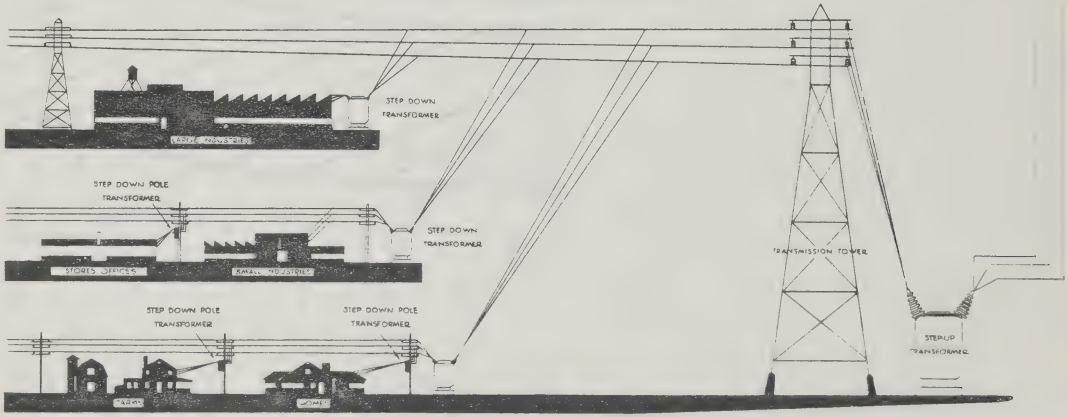
SIZE EFFECT UPON
INVESTMENT PER KW.
Coal Fired Steam Plant
Three Unit Plant



This drawing shows how coal and water is used in a modern steam generating station to make the electricity used in factories, stores and homes.

FIGURE II




POWER AND LIGHT BY Canadian Utilities LIMITED

FIGURE III

EFFECT OF SIZE ON BUS BAR COSTS

Assumed: 50% Reserve & 50% L.F.

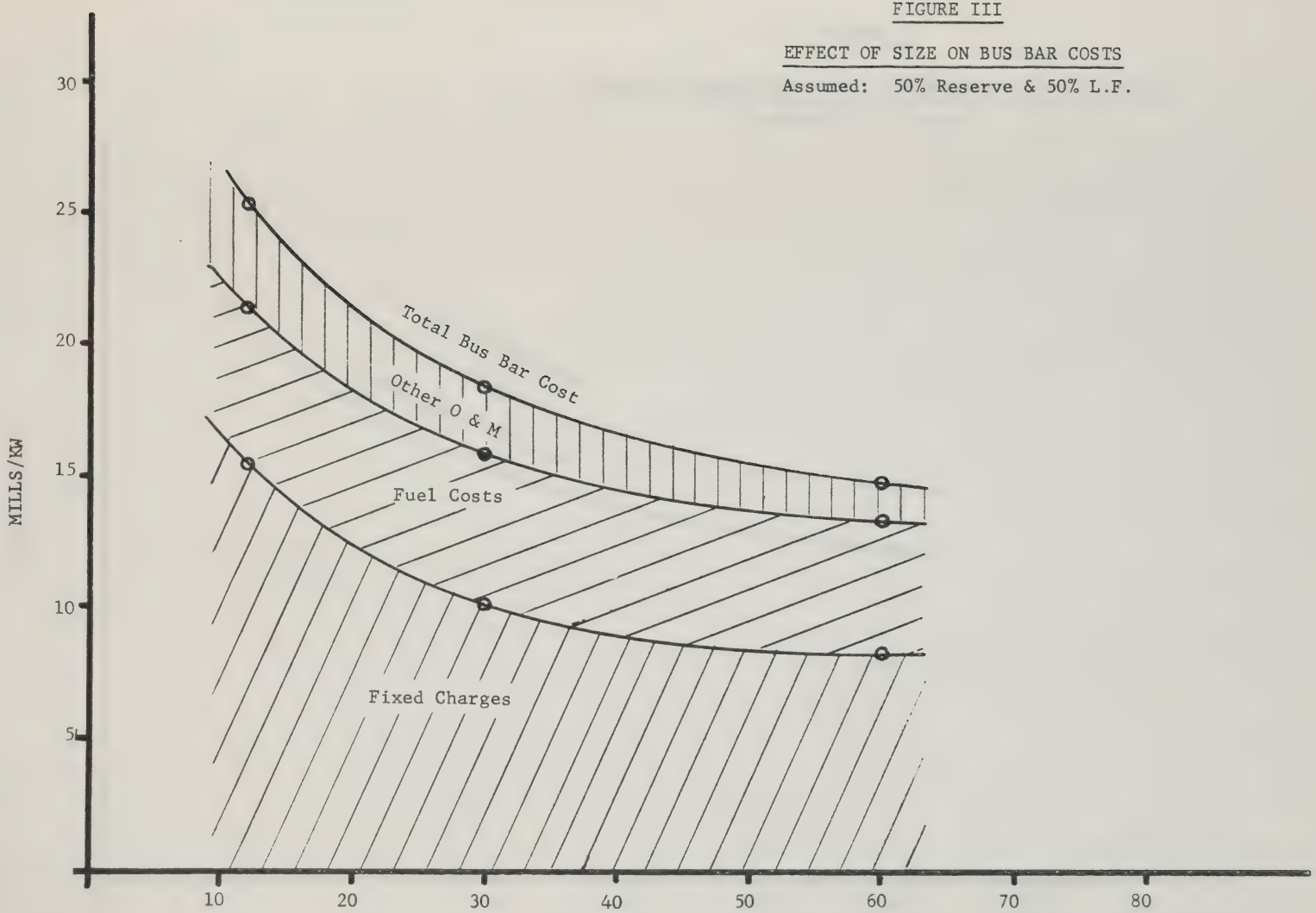


FIGURE IV

EFFECT OF MARGIN OF RESERVE CAPACITY ON BUS BAR COSTS

Assumed: L.F. @ 50%

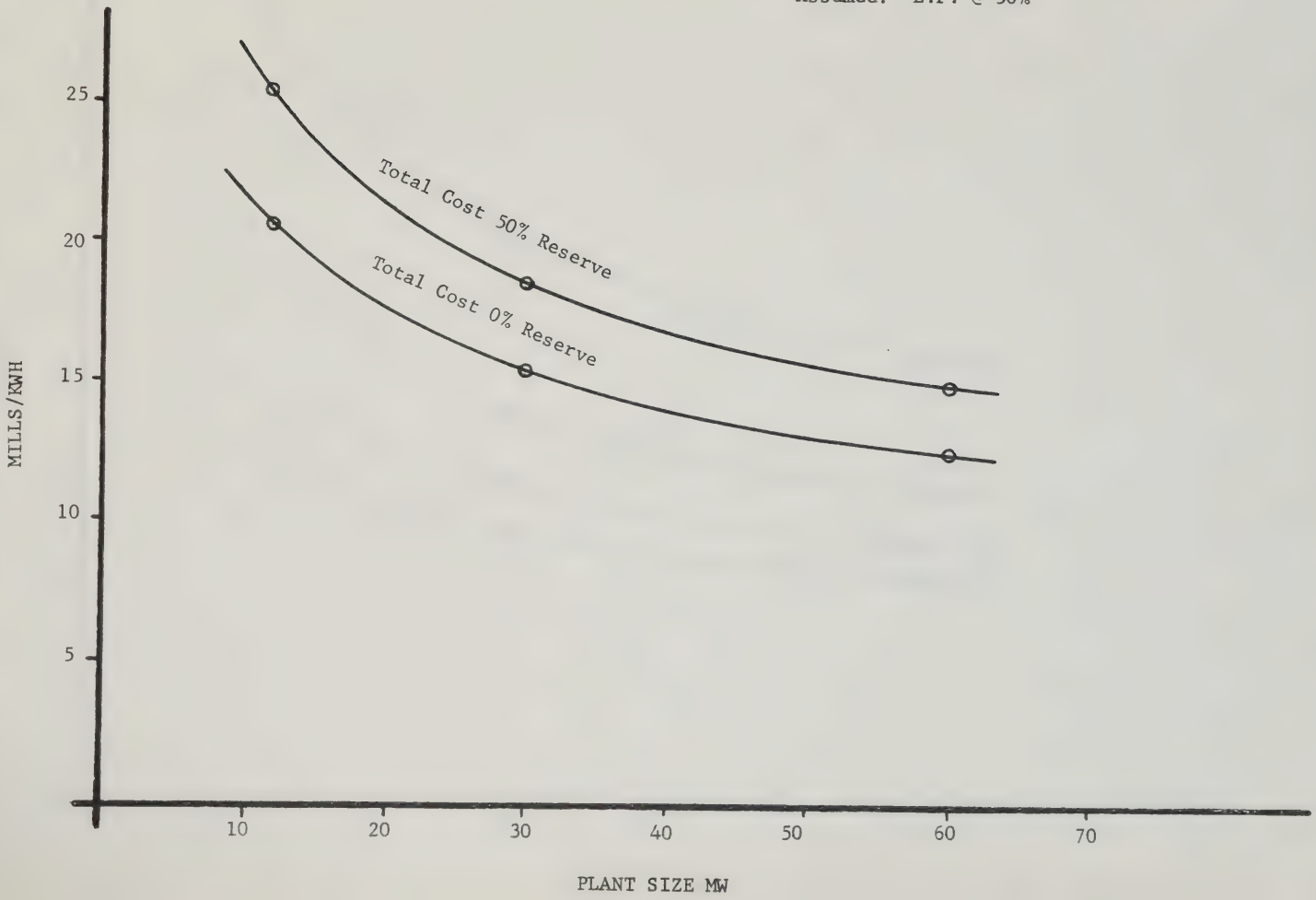


FIGURE V

EFFECT OF LOAD FACTOR ON BUS BAR COSTS

Assume: 50% Reserve Capacity